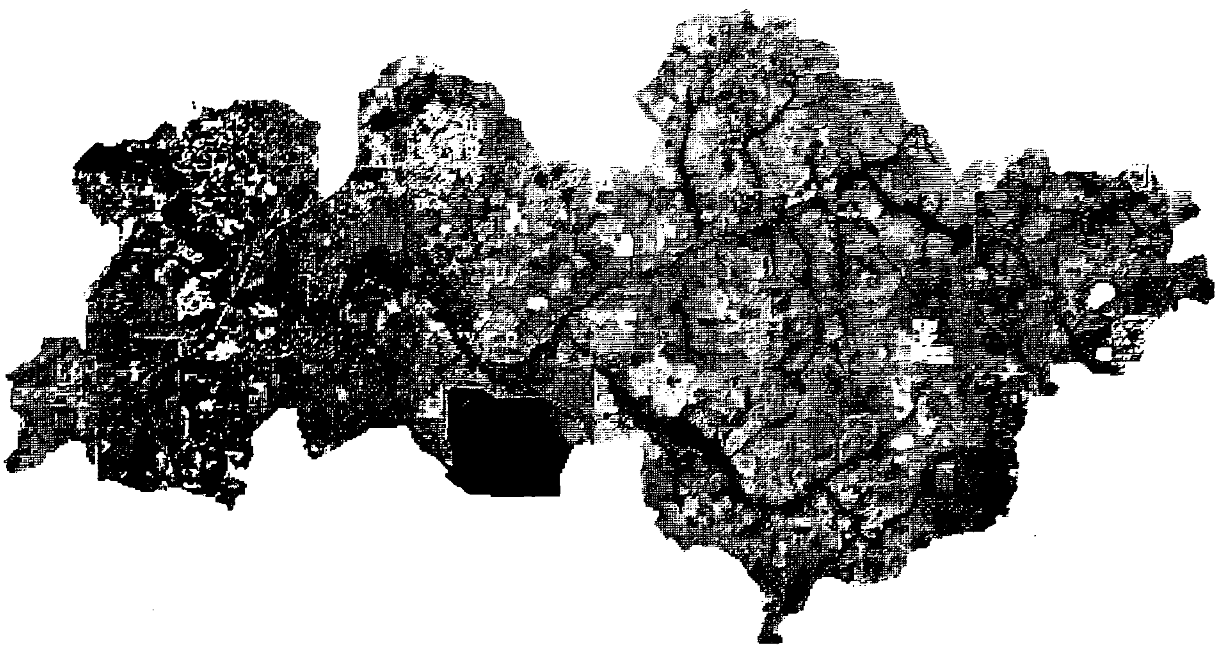
MARINE RESOURCES GEOGRAPHIC INFORMATION SYSTEM

FINAL REPORT

MARCH 1993



A report of the Florida Department of Community Affairs pursuant to National Oceanic and Atmospheric Administration Award No. NA270Z0345-01.

MARINE RESOURCES GEOGRAPHIC INFORMATION SYSTEM

FINAL REPORT

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Department of Natural Resources
Division of Marine Resources
Florida Marine Research Institute

A report to the Florida Department of Community Affairs pursuant to National Oceanic and Atmospheric Administration Award No. NA270Z0345-01.

EXECUTIVE SUMMARY

Task I. MARINE RESOURCES GEOGRAPHIC INFORMATION SYSTEM

Subtask A: The Little Manatee River (LMR) watershed, located on the eastern shore of Tampa Bay, Florida was selected for a multi-disciplinary project focusing on the development of watershed-oriented resource management tools and strategies. The project is a cooperative effort among federal, state, regional, and local agencies. The relatively pristine LMR watershed includes portions of two counties, and 36 subbasins draining 573 km^2. The dominant land use in the watershed is agricultural. The recent completion of Interstate-75, however, provides a major corridor for growth that will undoubtedly impact a significant portion of the watershed.

Subtask A focused on the completion and analysis of data layers for the Little Manatee River watershed of the Marine Resources Geographic Information System (MRGIS). The database was also distributed and subsequently integrated into other GIS systems.

A major component of the project was the development of the Little Manatee River Watershed Atlas, a 20-page map atlas featuring all of the primary data layers for the watershed. The color atlas was developed for use as a desk-top reference. The atlas consists of individual map sheets and mylar overlays and the four-ring design allows easy removal of individual map sheets. Co-registration of map pages allows real-time analysis. For example, by placing the transportation mylar over the flood zone map, roads prone to flooding can be easily identified. This information could be useful to disaster planners in identifying evacuation routes for emergency situations.

In addition to the primary data layers, the results of analyses are also featured in the atlas. An example of one MRGIS analysis is the identification of lands within the 100-year flood plain. The identified areas were subsequently queried based on the future land use data layer. The result of the query shows the future land use of only those areas that are within the 100-year flood plain.

<u>Data Layer Development</u>

All data layers were verified and finalized during this grant period. In addition, two layers, section-township-range (s-t-r) and septic tank density were identified as being critical to analysis, and were subsequently added to the database. The s-t-r coverage was created as an ARC/INFO file by the Southwest

Florida Water Management District (SWFWMD) and imported into the MRGIS. This vector-based coverage was then employed as the base coverage for a file showing septic tank densities by s-t-r which were entered manually.

Modeling and Analysis

Rainfall-runoff-water quality relationships were modeled relative to hydrologic characteristics at the request of SWFWMD. Model results were supplied to SWFWMD in the form of acreage tables. In most cases, they requested that individual models be run for the entire watershed, and then separately for each of the 10 hydrologic gaged units. The separation into gaged units allowed comparison with other SWFWMD databases. For example, the District monitored water quality at biweekly intervals from January 26, 1988 to January 24, 1989 at seven streamflow sites within the watershed. These seven streamflow locations were used to develop the ten gaged units for the LMR watershed project. Because the soils in proximity to the river have the greatest potential impact on the water quality of the river in terms of runoff, analyses were also conducted for a 500-ft buffer surrounding the river channels.

The LMR database was developed in either the vector or raster environment, depending upon the source material of the coverage being created. When analyses warranted, data were transferred to the alternate format using the standard conversion routines available through ERDAS and ARC/INFO software.

Data Distribution

ARC/INFO vector coverages were transferred to, and used by, Hillsborough County Engineering Department, the Southwest Florida Water Management District (SWFWMD), Florida Department of Natural Resources in Tallahassee, and the Department of Environmental Regulation. The LMR database is currently being used by SWFWMD to conduct water quality analyses. The Cockroach Bay Consensus Group, as directed by the Tampa Bay Regional Advisory Committee, identified the LMR database as a source of essential data due to the proximity of the watershed to Cockroach Bay. Digital data were requested by, and provided to, Hillsborough County to incorporate into their GIS. County managers will use this database in decisions that will impact the Cockroach Bay area, as well as the Little Manatee River watershed. An Ecological Working Group was established within the Florida Department of Natural Resources to identify major ecosystem issues which cross Division boundaries. The Little Manatee River watershed was chosen as the Ecosystem Pilot Project. As a result, the digital database was transferred to Tallahassee to develop specific scenarios and determine their potential impacts using the GIS. The Working Group is comprised of each of the FDNR Division Directors or their designees, with the goal of developing a strategic plan to manage Florida's natural resources using an ecosystem approach.

Data Documentation

Coverages of the MRGIS have been used to test the functionality of the metadata templates (Data Dictionary and Quality and Accuracy Report) being developed through the Growth Management Data Network Coordinating Council (GMDNCC). Analyses have indicated that minor changes to the templates are needed to increase their utility. These completed templates, when transferred with the digital data, provide valuable information which can be used by the recipient of the database in evaluating appropriate uses of the data.

Subtask B: Over 300 requests for information were handled by the MRGIS during this grant period (average of 21.5 requests/month). There were a total of 147 requests answered during the previous grant period (January 1, 1991 to January 31, 1992) for an average of 11.3 requests/month. This represents a nearly 50% increase over last year. Information output formats included hardcopy maps, digital data, presentations, and demonstrations. A substantial effort was focused on this subtask due to the large number of requests. The significant increase in requests for information demonstrates the need for effective dissemination of marine resources information, and signifies the importance of the MRGIS in coastal management.

Task I. MARINE RESOURCES GEOGRAPHIC INFORMATION SYSTEM
Little Manatee River (LMR) watershed database analyses and local government interface, data dissemination and updating.

Subtask A: Complete work with regional and local governments to integrate the MRGIS data and concepts into the planning and policy making processes. Analyze MRGIS data relative to watershed characteristics, water quality, and fisheries distribution and abundance.

INTRODUCTION AND SUMMARY

Subtask A focused on the completion and analysis of data layers for the Little Manatee River watershed of the Marine Resources Geographic Information System (MRGIS). The database was also distributed and subsequently integrated into other GIS systems. Rainfall-runoff-water quality relationships were modeled relative to hydrologic characteristics at the request of the Southwest Florida Water Management District (SWFWMD). SWFWMD was also the primary recipient of the digital database that was assembled for the watershed.

The comprehensive database consists of the following GIS coverages: SPOT satellite basemap; 1988 land use/land cover; detailed soils; 2 ft elevation contours; Federal Emergency Management Agency (FEMA) flood zones; future land use; drainage; game and fish habitat cover and plant communities; subbasins; hydrographic gage station subdrainage areas; wastewater treatment facility locations; consumptive use permit locations; permitted well locations; hydrology; transportation; section-township-range zones, and septic tank densities.

A major component of the project was the development of the Little Manatee River Watershed Atlas, a 20-page map atlas featuring all of the primary data layers for the watershed. A small scale copy of the atlas is shown in Appendix A. These 8 1/2" x 11" sheets were printed at a scale of 1:180,000. The full-scale color atlas, at a scale of 1:80,000, was developed for use as a desk-top reference. Design of the atlas incorporates individual map sheets and mylar overlays. The four-ring design allows easy removal of individual map sheets. Co-registration of map pages allows real-time analysis. For example, by placing the transportation mylar over the flood zone map, roads prone to flooding would be identified. This information could be useful to disaster planners in identifying evacuation routes for emergency situations. The 500-ft buffer overlay could be used to identify sensitive areas for effective resource management.

In addition to the primary data layers, the results of analyses are also featured in the atlas. An example of one MRGIS analysis is the identification of lands within the 100-year flood plain. The identified areas were subsequently queried based on the future land use data layer. The result of the query shows the future land use of only those areas that are within the 100-year flood plain. Based upon the adopted future land use map designations, approximately 42,692 dwelling units can be developed within this area of 22,464 acres.

DATABASE DEVELOPMENT

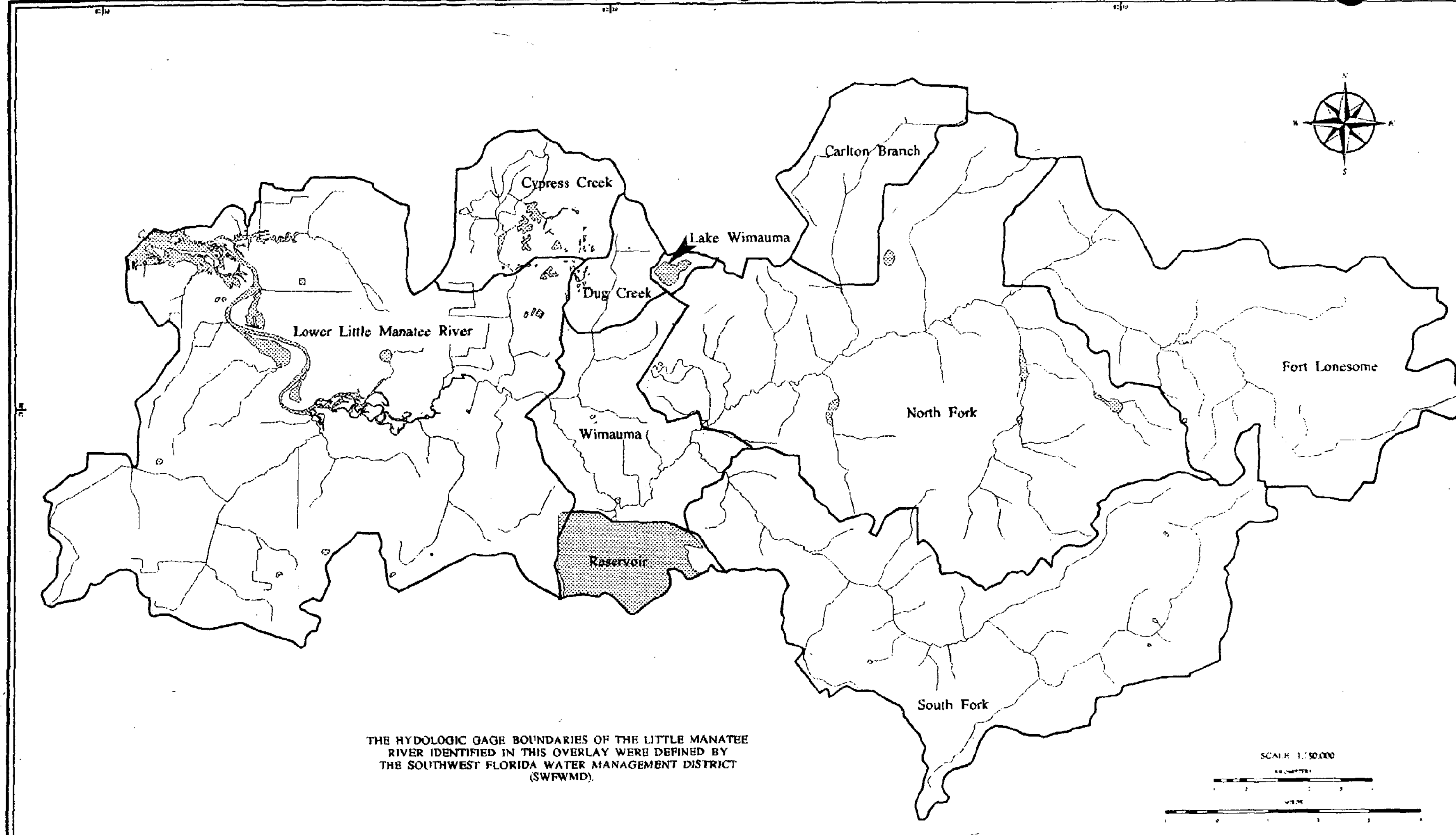
All spatial data are stored and analyze using the Marine Resources Geographic Information System (MRGIS) at the Florida Department of Natural Resources's Marine Research Institute in St. Petersburg. The MRGIS applications software includes the commercially available ERDAS, Inc. raster-based package, ESRI's ARC/INFO vector-based package, and ELAS, a non-proprietary image processing software developed by NASA.

MRGIS hardware configuration consists of the following: SUN 4/490 SparcServer with 4 1-gigabyte drives; 2 SparcStation 1+ workstations with 669 megabyte disk each; and 3 SparcStation IPX workstations, each with 1.3 GB disk. A five platter optical juke box, with each platter having 5 gb capacity, currently serves as an archival device for the MRGIS. Two 386 personal computers are accessible through the network. Hardcopy plots are generated primarily by a Calcomp 68436 XP electrostatic plotter. In addition, a Calcomp 1044GT 8-pen plotter, a Tektronix 4696 ink jet printer, and a Tektronix 4693DX thermal wax printer provide plotting/printing support. Printing of text is accomplished by a SUN SparcPrinter.

All data layers were verified and finalized during this grant period. In addition, two layers, section-township-range (s-t-r) and septic tank density were identified as being critical to analysis, and were added to the database. The s-t-r coverage was created as an ARC/INFO file by the Southwest Florida Water Management District (SWFWMD) and imported into the MRGIS. This vector-based coverage was then employed as the base coverage for a file showing septic tank density by s-t-r which were entered manually.

Models

The detailed soil database, developed in cooperation with the U.S. Department of Agriculture, Soil Conservation Service (SCS), is a valuable layer



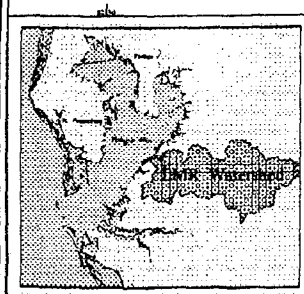


FIGURE 1. Drainage and Hydrologic Gage Boundaries

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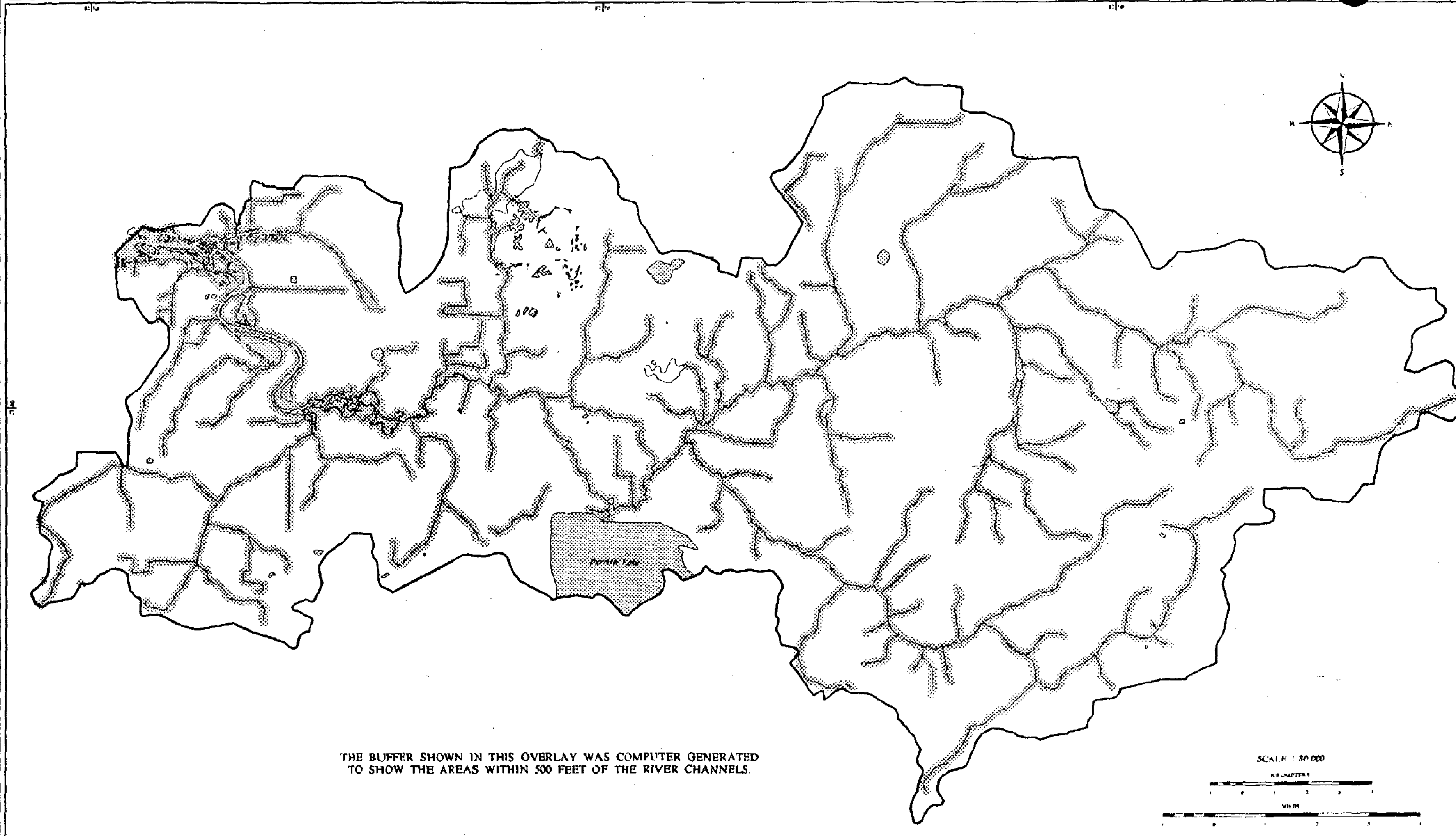

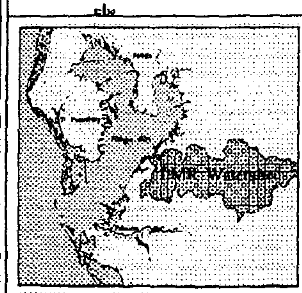

FIGURE 2. 500 Foot Buffer of the Little Manatee River

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in developing analyses relating to watershed characteristics and water quality. There are 111 discrete soil classifications that fall within the Little Manatee River watershed (Hillsborough and Manatee Counties). There is an accompanying database in which 80 soil characteristics are defined for each of the 111 soil classes. The soil characteristics, or attributes, include important information pertaining to each soil. Some important soil characteristics include: texture; liquid limit and plasticity index; clay percent; moist bulk density; permeability; available water capacity; soil reaction; salinity; shrink-swell potential; corrosivity to steel; corrosivity to concrete; erosion factors; wind erodibility groups; percent organic matter; flooding; hydrologic groups; suitability for building site development and use as construction materials; capability and predicted yields for crops and pasture; woodland suitability; wildlife suitability; and potential plant community (Doolittle et al., 1989).

Data for each of the 80 attributes, arranged by soil type, were provided to the Florida Marine Research Institute as ASCII text files by SCS. These files were manipulated so the attribute array could be incorporated into both the ARC/INFO vector coverage and the ERDAS raster file.

Several models were developed in response to requests from the Southwest Florida Water Management District (SWFWMD) for use in their evaluation of water quality characteristics within the LMR watershed. Results of preliminary analyses pertaining to water quality are discussed in Flannery et al., 1991. Model results were supplied to SWFWMD in the form of acreage tables. In most cases, the SWFWMD requested that individual models be run for the entire watershed and then separately for each of the 10 subdrainage areas or hydrologic gaged units. The separation into gaged units allowed comparison with other SWFWMD databases. For example, the District monitored water quality at biweekly intervals from January 26, 1988 to January 24, 1989 at seven streamflow sites within the watershed. These seven streamflow locations were used to develop the ten gaged units for the LMR watershed project (Figure 1). Because the soils in proximity to the river have the greatest potential impact on the water quality of the river in terms of runoff, analyses were also conducted for a 500-ft buffer surrounding the river channels (Figure 2).

One of the most frequently used attributes within the soil database is hydrologic group which provides information used to estimate runoff from precipitation. Hydrologic units are divided into four different groups: Group A - low runoff potential (soils having a high infiltration rate); Group B - (soils having a moderate infiltration rate); Group C - (soils having a slow infiltration rate); and Group D - high runoff potential (soils having a very slow infiltration rate). The soil hydrologic units for the watershed, for each of the hydrologic

Table 1. Area (in hectares) of soil groups for the overall watershed, each gaged unit, and within the 500-ft buffer of the river.

Hydrologic Buffer	Summary	Gage 1	Gage 2	Gage 3	Gage 4	Gage 5
A	3934	513	0	4	216	0
B	223	74	0	0	68	0
C	8295	1126	46	63	709	14
D	3912	1486	664	48	52	2
B/D	39394	13280	1246	726	1797	70

Hydrologic Buffer	Gage 6	Gage 7	Gage 8	Gage 9	Gage 10	500-ft buffer
A	3	416	852	1527	415	674
B	0	0	0	82	0	94
C	52	401	2397	2152	1359	8[illegible]
D	27	87	643	432	474	1256
B/D	42	1282	9395	5861	5744	10453

Table 2. Area (in hectares) of soil hydrologic group by land cover for each of the 10 gaged units.

	A		B		C		D		B/D		Water	
Gage 1	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Wetland	38	1	21	1	21	1	982	30	2185	66	41	1
Water	10	1	1	<1	18	2	75	10	134	18	527	69
Agriculture	149	2	36	<1	711	9	198	2	6935	86	4	<1
Upland	187	7	6	<1	208	7	77	3	2315	83	4	<1
Urban	127	6	10	<1	167	8	155	7	1707	78	20	1

	A		B		C		D		B/D		Water	
Gage 2	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Wetland	---	---	---	---	1	<1	310	67	142	31	8	2
Water	---	---	---	---	2	1	28	21	47	34	59	43
Agriculture	---	---	---	---	12	3	2	1	447	97	1	<1
Upland	---	---	---	---	3	3	5	4	97	92	<1	<1
Urban	---	---	---	---	28	3	319	36	513	58	31	3

	A		B		C		D		B/D		Water	
Gage 3	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Wetland	---	---	---	---	1	1	27	23	92	76	<1	<1
Water	---	---	---	---	---	---	1	13	5	60	3	28
Agriculture	3	1	---	---	22	6	12	3	326	90	---	---
Upland	1	<1	---	---	29	13	7	3	192	84	<1	<1
Urban	---	---	---	---	12	9	1	1	111	86	4	3

	A		B		C		D		B/D		Water	
Gage 4	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Wetland	26	5	13	3	31	6	27	5	395	80	<1	<1
Water	1	7	---	---	1	8	1	7	5	28	9	50
Agriculture	76	5	35	2	498	35	13	1	802	56	1	<1
Upland	103	15	19	3	139	20	6	1	438	62	<1	<1
Urban	9	4	<1	<1	40	18	4	2	158	72	9	4

	A		B		C		D		B/D		Water	
Gage 5	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Wetland	---	---	---	---	---	---	1	1	5	11	43	88
Water	---	---	---	---	3	<1	<1	<1	4	<1	1022	99
Agriculture	---	---	---	---	---	---	1	2	48	96	1	3
Upland	---	---	---	---	4	29	---	---	8	70	<1	1
Urban	---	---	---	---	8	60	---	---	4	27	2	14

Table 2 continued.

Gage 6	A Area	A %	B Area	B %	C Area	C %	D Area	D %	B/D Area	B/D %	Water Area	Water %
Wetland	---	---	---	---	<1	2	16	68	2	7	6	23
Water	---	---	---	---	---	---	2	7	1	4	33	90
Agriculture	<1	1	---	---	4	11	5	16	23	71	---	---
Upland	---	---	---	---	1	21	1	23	3	56	---	---
Urban	3	4	---	---	47	73	2	3	13	20	---	---

Gage 7	A Area	A %	B Area	B %	C Area	C %	D Area	D %	B/D Area	B/D %	Water Area	Water %
Wetland	14	7	---	---	3	2	40	22	129	69	---	---
Water	1	15	---	---	<1	2	1	6	7	69	1	8
Agriculture	347	19	---	---	381	21	41	2	1062	58	1	<1
Upland	5	12	---	---	5	11	2	4	33	74	---	---
Urban	49	42	---	---	12	10	4	3	52	45	---	---

Gage 8	A Area	A %	B Area	B %	C Area	C %	D Area	D %	B/D Area	B/D %	Water Area	Water %
Wetland	32	2	---	---	51	2	404	19	1595	76	2	<1
Water	<1	<1	---	---	3	6	18	37	13	26	15	31
Agriculture	527	6	---	---	1947	23	149	2	6018	70	1	<1
Upland	277	12	---	---	341	14	71	3	1676	71	---	---
Urban	16	10	---	---	55	33	1	1	93	56	---	---

Gage 9	A Area	A %	B Area	B %	C Area	C %	D Area	D %	B/D Area	B/D %	Water Area	Water %
Wetland	190	10	34	2	67	4	254	13	1378	72	<1	<1
Water	1	5	---	---	2	13	5	28	10	55	---	---
Agriculture	736	14	36	1	1489	27	99	2	3084	57	---	---
Upland	599	23	12	<1	579	22	69	3	1363	52	<1	0
Urban	1	3	<1	<1	7	41	<1	1	9	51	1	3

Gage 10	A Area	A %	B Area	B %	C Area	C %	D Area	D %	B/D Area	B/D %	Water Area	Water %
Wetland	5	<1	---	---	43	3	290	23	927	73	1	<1
Water	8	15	---	---	1	3	6	12	33	64	3	6
Agriculture	210	4	---	---	1175	24	93	2	3420	70	2	<1
Upland	40	3	---	---	118	9	49	4	1085	84	---	---
Urban	152	31	---	---	22	4	36	7	278	57	1	<1

Table 3. Area (in hectares) of soil K Factor ranges for the watershed, each gaged unit, and within the 500-ft buffer of the river.

K Factor	Summary	Gage 1	Gage 2	Gage 3	Gage 4	Gage 5	Gage 6	Gage 7	Gage 8	Gage 9	Gage 10	500-ft buffer
LE 0.16	54123	15290	1621	842	2841	86	124	2176	13228	10022	7979	12850
GT 0.16 & LE 0.22	0	0	0	0	0	0	0	0	0	0	0	0
GT 0.22 & LE 0.28	26	26	0	0	0	0	0	0	0	0	0	25
GT 0.28	10	0	0	0	0	0	0	10	0	0	0	0
soil not rated	3454	1760	434	7	20	1069	39	2	78	32	20	1046

Table 4. Area (in hectares) of soil permeability ratings within the watershed, for each gaged unit, and within the 500-ft buffer of the river.

Permeability	Summary	Gage 1	Gage 2	Gage 3	Gage 4	Gage 5	Gage 6	Gage 7	Gage 8	Gage 9	Gage 10	500-ft buffer
1	3699	345	335	60	140	0	27	525	1345	93	832	766
2	14242	2599	57	201	452	55	59	734	4071	2828	3207	3384
3	31165	10508	1195	560	1828	31	35	722	6739	6543	3064	6271
1A	193	193	0	0	0	0	0	0	0	0	0	188
2A	3940	2029	35	20	212	0	0	91	822	127	605	2267
undefined	2830	940	434	7	98	1069	39	21	58	5	167	642

Table 5. Area (in hectares) of soil water table depth minima and maxima for each of the gaged units. Depth ranges are given in feet.

Water Table Depth Minima by Hydrologic Unit

Depth Range	Total Watershed		Gage 1		Gage 2		Gage 3		Gage 4		Gage 5	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
< 0	145	< 1	134	1	0	0	0	0	0	0	0	0
0.0 to 1.0	44556	77	15103	89	1673	81	782	92	1869	65	1140	99
1.1 to 1.9	106	< 1	28	< 1	0	0	0	0	0	0	0	0
2.0 to 3.9	8757	15	1224	7	382	19	63	7	765	27	14	1
4.0 to 5.9	383	1	235	1	0	0	0	0	40	1	0	0
> 5.9	3665	6	352	2	0	0	4	< 1	187	7	0	0

Depth Range	Gage 6		Gage 7		Gage 8		Gage 9		Gage 10	
	Area	%	Area	%	Area	%	Area	%	Area	%
< 0	0	0	0	0	11	< 1	0	0	0	0
0.0 to 1.0	108	66	1371	63	10045	76	6294	63	6225	78
1.1 to 1.9	0	0	0	0	12	< 1	66	1	0	0
2.0 to 3.9	52	32	401	18	2385	18	2138	21	1359	17
4.0 to 5.9	0	0	16	1	3	< 1	89	1	0	0
> 5.9	3	2	400	18	849	6	1466	15	415	5

Water Table Depth Maxima by Hydrologic Unit

Depth Range	Total Watershed		Gage 1		Gage 2		Gage 3		Gage 4		Gage 5	
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
< 0	3338	6	1040	6	329	16	48	6	61	2	2	< 1
0.0 to 1.0	41469	72	14225	83	1345	65	734	86	1808	63	1139	99
1.1 to 1.9	1698	3	346	2	6	< 1	9	1	193	7	< 1	0
2.0 to 3.9	8990	16	1426	8	376	18	56	7	731	26	14	1
4.0 to 5.9	1063	2	5	< 1	0	0	0	0	28	< 1	0	0
> 5.9	1054	2	33	< 1	0	0	1	< 1	40	1	0	0

Depth Range	Gage 6		Gage 7		Gage 8		Gage 9		Gage 10	
	Area	%	Area	%	Area	%	Area	%	Area	%
< 0	27	17	77	4	716	5	551	6	487	6
0.0 to 1.0	81	50	1293	59	9352	70	5809	58	5738	72
1.1 to 1.9	0	0	136	6	429	3	320	3	259	3
2.0 to 3.9	55	34	400	18	2247	17	2488	25	1227	15
4.0 to 5.9	0	0	0	0	147	1	879	9	9	< 1
> 5.9	0	0	280	13	414	3	8	< 1	279	3

gaged units, and within the 500-ft buffer of the river are listed in Table 1. Calculations for the soil hydrologic unit within the 500-ft buffer of the river are also shown in Table 1. These values, in conjunction with other soil features, are used in land use planning that has engineering considerations. A model was developed to investigate the relationship between soil hydrologic groups and generalized land cover. The 1988 land cover layer, interpreted from aerial photography and the 1988 SPOT satellite basemap, was employed in this analysis. The results of this analysis for the whole watershed are shown in Table 2.

Soil erosion, the loss of soils by the forces of wind and water, from agricultural lands negatively impacts the water quality of the river. When soil erodes from agricultural lands, fertilizers and pesticides are also washed into storm drains and into the river. The soil K Factor is an estimation of the susceptibility of a soil to sheet and rill erosion by water (Doolittle et al., 1989). The K Factor is one of six factors used in calculating the Universal Soil Loss Equation. This equation predicts the average annual rate of soil loss by sheet and rill erosion. K values range from 0.02 to 0.69, higher values indicate a greater susceptibility of the soil to sheet and rill erosion by water. Within the Little Manatee River watershed, K values range from .05 to .32. The soil K Factor within the entire watershed, for each of the gaged units, and within the 500-ft buffer of the river are listed in Table 3.

Soil permeability, the ability of a soil to transmit water or air, was also investigated for the overall watershed, on the basis of each gaged unit, and within the 500-ft buffer. Results of these models are shown in Table 4. These estimates indicate the rate of movement of water through a saturated soil. Design of drainage systems and septic tank absorption fields must consider soil permeability.

Another attribute of interest to the SWFWMD is water table depth. This attribute is reported as two separate values which indicate the normal range in depth to a saturated zone. Depths are recorded to the nearest half foot and reflect the normal highest level and the normal lowest level. Water table ranges by gaged unit are given in Table 5.

Data Conversion & Transfer

The LMR database was developed in either the vector or raster environment, depending upon the source material of the coverage being created. When analysis warranted, data were transferred to the alternate format using the standard conversion routines available through ERDAS and ARC/INFO software.

The complexity of the SPOT satellite basemap, however, dictated that the usage of this data layer be restricted to the raster environment. Although data analyses were conducted in both formats, ARC/INFO vector coverages were easily transferred to and used by Hillsborough County Engineering Department, the Southwest Florida Water Management District, and Florida Department of Natural Resources in Tallahassee. Both SWFWMD and FDNR have selected ARC/INFO as their primary vector GIS software. Hillsborough County utilizes GENAMAP software which contains algorithms capable of converting ARC/INFO export coverages into a usable format. The LMR database has been transferred to SWFWMD and is currently being used to conduct water quality analyses.

Selected coverages of the Little Manatee River watershed database were transferred to the Hillsborough County Engineering Department. This transfer was facilitated by the formation of the Cockroach Bay Consensus Group as directed by the Tampa Bay Regional Coordinating Council (TBRCC). The TBRCC has four goals: promote the sharing of data related to growth management; promote consistency of data elements; adopt common data elements and formats for interagency transmission of data where feasible; and avoid the duplication of effort associated with the collection of data. The Cockroach Bay Consensus Group developed a matrix to identify critical data layers relative to Cockroach Bay and agencies that possess them. The LMR database was identified as providing essential data due to the proximity of the watershed to Cockroach Bay. The estuarine portion of the watershed, which includes the mouth of the river, is of particular interest as it lies within the boundaries of the Cockroach Bay Aquatic Preserve. Digital data were provided and incorporated into the Hillsborough County GIS. County managers will use this database in decisions that will impact the Cockroach Bay area, as well as the Little Manatee River watershed.

An Ecological Working Group has been established within the Florida Department of Natural Resources to try to identify major ecosystem issues which cross Division boundaries. The Little Manatee River watershed has been chosen as the Ecosystem Pilot Project. As a result, the digital database was transferred to Tallahassee so that specific scenarios may be developed, and their potential impacts determined, using the GIS. The Working Group is comprised of each of the DNR Division Directors or their designees with the goal of developing a strategic plan for managing Florida's natural resources using an ecosystem approach.

To maximize the utility of digital data, it is necessary to document the creation of each data layer. This history or lineage is then included when the digital data are transferred. Such data about data are referred to as metadata.

The TBRCC has been working with the Growth Management Data Network Coordinating Council (GMDNCC) to develop a Data Dictionary and Quality and Accuracy Report. The Data Dictionary template is used to define the data, and ensures that classification systems are fully explained. The Quality and Accuracy Report documents standards and techniques employed to develop the data. The valuable information in the two completed templates, when transferred with the digital data, allow the recipient of the database to evaluate appropriate uses of the data. In some cases, the metadata provided in either template might indicate a discrepancy in an item definition or source map scale that would limit the utility of the database for the second-hand user. Knowledge of such limitations are critical in developing responsible uses for the data.

Coverages of the MRGIS database have been used to test the functionality of the metadata templates. Analyses have indicated that minor changes to the templates are needed to increase their utility. A sample of the template is attached (Appendix B).

Subtask B: Distribute MRGIS digital, tabular and hardcopy habitat data, maps, images, and other pertinent MRGIS information. Update habitat data and conduct trend analyses for areas of special focus.

Information Requests

Responding to requests for information to better manage and understand our coastal resources is an important aspect of Marine Resources Geographic Information System (MRGIS) activities. During the course of this grant, 302 requests for information were filled. In some cases, requests are straightforward in that the data requested are readily available on the MRGIS, and further data analysis is not required. We have developed some standard map products that have broad use and are capable of filling multiple requests. In most cases, however, manipulation and analysis of the data are required to fit individual requestor's needs.

The following are examples of the types of analyses conducted in response to requests for assistance during this grant period:

A series of maps depicting the relationship among water depth, seagrasses, and areas of food and bait shrimp harvesting were developed as the result of a request from the Florida Marine Fisheries Commission. This map series has come to be known as the Resource Impact Maps (RIMs). Thirteen segments within five regions were defined for the State. The nature of the RIMs required that some databases be developed. Areas of shrimp harvesting, for example, were not known. During numerous public hearings, shrimpers indicated those areas they shrimped by drawing polygons on NOAA nautical charts. Charts were returned to the FMRI and the "shrimping" polygons were digitized into the MRGIS. Seagrass data for some of the segments were considered historical and required updating. A contract was established to digitize bathymetry data (3 ft, 6 ft, 12 ft, 18 ft, 30 ft, and 60 ft) to automate the water depth component. Draft maps for twelve of the thirteen segments have been completed: Pensacola Bay, Choctawhatchee Bay, St. Andrew Bay, St. Joseph Bay, Apalachicola, Big Bend, Tampa Bay, Charlotte Harbor, Everglades, Florida Keys, Biscayne Bay, and St. Johns River. The Indian River segment is in progress. Big Bend is the only segment that is in final form (includes shrimping zones). As a result of this effort a manuscript (Appendix C) has been accepted for presentation and publication at Coastal Zone '93.

MRGIS staff was requested to assist FMRI Marathon Field Station personnel in designing a map atlas to be used for recording boater activity in the Florida Keys and in designing a database to enter the survey results. The Florida Keys Boat Use Pattern study is an 18-month long project that will map boat use patterns in the Florida Keys and determine boating pressure on sensitive marine habitats. The principle tool in tracking boater activity will be aerial survey. The atlas consists of a series of 26 maps within the boundaries of the Florida Keys National Marine Sanctuary as far west as the Marquesas Keys. A one-minute grid was superimposed over the atlas pages to create blocks into which data could be recorded. The prototype of the survey atlas was field-tested and a preliminary database design for data entry was provided. Final survey data will be included in the MRGIS. To date, preliminary data have been entered and draft maps have been created for interim reports to The Nature Conservancy. Numerous copies (40+) of the survey atlas have already been provided to the requestor for this study. Furthermore, numerous requests for the atlas have come from as far away as California and Maine.

Dr. Gray Multer requested a map depicting benthic communities, main geologic formations, latitude and longitude, and park boundaries in the Florida Keys. The map was created to Dr. Multer's exact specifications to accommodate his text and photographs. The Florida Institute of Oceanography plans to produce and distribute 15,000 of these maps in the Florida Keys for educational purposes.

A Tampa Bay Boaters' Guide was developed in cooperation with the Tampa Bay National Estuary Program (NEP) at their request. This map will provide important marine resources information, as well as tips on safe-boating practices, to recreational boaters in Tampa Bay. MRGIS data layers featured in the Boaters' Guide are: marine habitat, bathymetry, public boat ramps and marinas, artificial reefs, navigational aids, major roadways, cultural features, and landmarks. Data were provided as individual layers to a printing shop for final map assembly. The flip side of the map features drawings and descriptions of fishes common to Tampa Bay, and text on the importance and sensitivity of marine habitats to the health of the estuary.

Many analyses involve conversion between raster and vector formats. These conversions are routinely performed in response to requests for data. In many cases, conversion also occurs between projections. Under normal circumstances, MRGIS data are developed in the Universal Transverse

Mercator (UTM) projection. When warranted, data are projected into other coordinate systems. An example of this type of conversion was performed for the Florida Institute of Oceanography who required data in latitude and longitude.

The following summarizes the types of output and general forms of resource management information provided:

Information has been provided in several forms, the most common form of assistance requested being hardcopy maps. These maps are available in three formats: electrostatic plots, thermal wax prints, and ink jet prints. Although we can produce pen plots, this is seldom utilized due to the superior quality and significant reduction in plot time of the electrostatic plotter. The electrostatic plotter is capable of plotting maps up to 34 inches long on paper or clear mylar. This plotter played a significant role in the preparation of the Little Manatee River Atlas. Large-scale plots can be created by joining individual plotter sheets. Nine panels were assembled to create a 144" x 76" map to fill a request from NOAA for use in developing the Florida Keys National Marine Sanctuary Management Plan. The thermal wax and ink jet printers continue to be used primarily for printing raster data. An example of this type of request came from Mr. Peter Clark of the Tampa Bay Regional Planning Council, who requested prints reflecting changes in mangroves for the Sarasota Bay area between 1950 and 1982. The nature of the request required the following areas be defined: areas that were mangrove in 1950 that were unchanged in 1982, 1950 mangrove areas that were not mangroves in 1982, and 1982 mangrove areas that were not present in 1950. These trends were determined and results featured in thermal wax prints suitable for inclusion in a report.

We continue to provide digital data on a routine basis to those agencies requesting it. We have noted an increase in the number of requests for digital data. When digital data are requested, the typical output is an ERDAS or ARC/INFO export file. These files are machine independent and are readily useable by agencies with these software packages. Conversions of these data to other formats are performed on an as-needed basis. Standard output media include 8 mm 5 gb tape cartridges, 1/4 inch 150 mb cartridges, 9-track tapes, and in the cases of small data sets, floppy disks.

Results of GIS manipulations are also commonly requested in tabular format. Acreage of marine habitat data for specific areas are frequent requests. Requestors are asked to provide the boundaries of the area of interest and the acreages are calculated based on the defined area. An example of this form of request came from Roger Johansson of the City of Tampa, Department of Sanitary Sewers. Dr. Johansson requested a tabulation of the number of acres of seagrass that occur in Tampa Bay within depths of 3 and 6 feet for specific areas of the bay system. These data are being used to assist in the determination of areas that could support seagrasses as water quality problems are ameliorated.

Slides or overheads featuring MRGIS coverages and results of GIS analyses are also supplied to individuals who use them in presentations or discussions on the health of marine resources. For example, several slides and overheads of the Florida Bay area were supplied to George Barley of the NOAA Florida Keys National Marine Sanctuary to be used in presentations concerning the Sanctuary.

MRGIS staff have distributed information by participating on intergovernmental committees, giving public presentations, and conducting tours and demonstrations of the MRGIS. This interaction is a strong component of the MRGIS and assists us in understanding management and user needs. It also provides a forum to keep recreational fish a priority in research, environmental planning, growth management, and public opinion.

The following summarizes the 302 MRGIS requests:

Ruth Folit, New College, Sarasota, FL - Information and review of aerial photography and propeller scar mapping for the Sarasota Bay area.

Connie Stevens, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Review of available nautical charts and marine habitat for research area to be used in presentation.

Walter Jaap, Jennifer Wheaton, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Evaluation of nine photographs for accuracy of underwater photogrammetric aperture for mapping coral growth in the Florida Keys.

Alice Bard, Florida Department of Natural Resources, Division of Recreation and Parks, Clermont, FL - Prints of 1950 and 1982 land cover for the St. Joseph Sound area to be used in seminar series.

William Teehan, Florida Marine Fisheries Commission, Tallahassee, FL - Resource Impact Map of the Panama City area broken into three large-scale sections.

Dr. Joseph Kimmel, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Aerial photographs of the Dry Tortugas area for reef fish research.

Tom Wallace, Private Citizen, St. Petersburg, FL - Revised Resource Impact Map for the Cedar Key/Big Bend area featuring benthic communities and bathymetry. These data will be used to determine potential aquaculture locations in the Cedar Key area.

Bob Heagey, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Seagrass maps of the Banana River.

Tom Wallace, Private Citizen, St. Petersburg, FL - Boundary map of the St. Martin's Marsh Aquatic Preserve. The information will be used to ensure that potential aquaculture sites will not be selected within the Preserve.

George Henderson, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Two Resource Impact Maps of the Tampa Bay area to be presented at the Tampa Bay Oil Spill Contingency Workshop.

Scott Zengel, U.S. Fish and Wildlife Service, Gainesville, FL - Seagrass distribution maps of the Cedar Key area. U.S. F&WS will be remapping the seagrass in this area and will provide us with updated maps.

Matthew Clemons, Florida Department of Natural Resources, Crystal River, FL - Information on the Weedon Island propeller scar mapping project.

Paula Houhoulis, University of Georgia, Athens, GA - Information on the mapping of boat propeller scar damage to seagrasses.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Maps of three grids (1-, 2-, and 3-minute) to assist in the development of a geographic segmentation scheme for the COMPAS project.

Michael Gilbrook, East Central Florida Regional Planning Council, Winter Park, FL - Information on marine resources data for the Indian River Lagoon. These data will be included in the National Estuary Program's inventory of natural resource data available for the Indian River area.

Ed Irby, Florida Department of Natural Resources, Office of Fisheries Management and Assistant Services, Tallahassee, FL - Two Resource Impact Maps of Tampa Bay and the Florida Keys.

Skip Snow, Everglades National Park, Homestead, FL - Digital coverage of the Monroe and Collier County area featuring the Florida shoreline and NOAA Aids to Navigation.

Kathy Swanson, Florida Department of Environmental Regulation, Tallahassee, FL - Digital file of the 1-, 2-, and 3-minute grids for the Florida Keys area.

Barry Douglas, Coastal Technology Corporation, Vero Beach, FL - Map featuring benthic communities for the John's Pass (1:24,000 scale) and Tampa Bay (1:100,000 scale) areas.

Mike Phillips, Florida Department of Natural Resources, Tallahassee, FL - Eight plots of the Little Manatee River watershed to be used for ecosystem evaluation.

Jennifer Bexley, University of South Florida/U.S. Geological Survey, Tampa, FL - Assistance with aerial photography for USGS Coastal Center to be used in a change analysis for the St. Petersburg area from 1962 to 1992.

Dale Beaumariage, U.S. Fish & Wildlife, Division of Federal Aid, Atlanta, GA - Map featuring the 1990 seagrasses, boat ramps, artificial reefs, and bathymetry data for the Tampa Bay area. This map was used for the American Tackle Manufacturer's Association Conference in Miami.

William G. Theiss, Lindahl, Browning, Ferrari, and Hellstrom Inc., Fort Pierce, FL - Digital files of the Florida Keys shoreline, the Florida Keys National Marine Sanctuary, and road network.

Joseph O'Hop, Florida Department of Natural Resources, Florida Marine Research Institute, Fisheries Statistics Section, St. Petersburg, FL - Map of the Tampa Bay region featuring benthic communities, boat ramps, artificial reefs, bathymetry, and two insets of Cockroach Bay and Boca Ciega Bay at 1:24,000 scale.

Dr. Luis Lagera, Continental Shelf Associates, Jupiter, FL - Four maps featuring land, seagrass, coral, and bathymetry within the Florida Keys National Marine Sanctuary and four maps showing everything in the map series to support phase II of the water quality component.

Joseph Szemer, Sunshine Travel, St. Petersburg, FL - Map featuring resources from Tarpon Key to Ft. DeSoto for fishing areas.

Billy Causey, NOAA, Marathon, FL - Plot featuring benthic resources for the Florida Keys National Marine Sanctuary. These data were requested to evaluate the classification scheme for the area.

Merrie Beth Neely, Pinellas County Department of Environmental Management, Clearwater, FL - Information on seagrass loss in the Tampa Bay area.

Tom Matthews, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Five sets of aerial survey charts. These map atlases were distributed to sanctuary managers. In addition, nine copies of the master grid chart were provided.

Dr. Gray Multer, Multer and Associates, Arkport, NY - Map featuring benthic communities inside the Florida Keys National Marine Sanctuary. In addition, three plots showing the FKNMS and land (without benthic communities).

A. Hart, Continental Shelf and Associates, Jupiter, FL - Information on the Florida Keys National Marine Sanctuary classification system and water quality monitoring.

Mike Sole, Florida Department of Natural Resources, Division of Beaches and Shores, Tallahassee, FL - Bathymetry and benthic resources for the Smathers Beach area. These data will be used for an environmental impact assessment of the proposed beach renourishment project.

Wanda Prentiss, Florida Department of Natural Resources, Division of Submerged Lands, Tallahassee, FL - Evaluation of Minerals Management and National High Altitude Program (NHAP) photography to identify bottom features. This information was used for aquatic leases.

John Glisch, Orlando Sentinel, Orlando, FL - Information on fisheries habitat and the effect of seagrass, tidal marsh and wetlands loss due to development.

Alice Bard, Florida Department of Natural Resources, Division of Recreation and Parks, Clermont, FL - Three prints of the 1950 and 1982 land cover database for the northern Pinellas County area.

John Labie, Florida Department of Environmental Regulation, Tallahassee, FL - Digital data of the Florida shoreline database and bathymetry for the Biscayne Bay area.

Bob Repenning, Florida Department of Natural Resources, Southwest Florida Aquatic Preserves Office, Bokeelia, FL - Review of aerial photographs for seagrass damage for the channel marking project.

Kathy Swanson, Florida Department of Natural Resources, Bureau of Sanctuaries and Reserves, Tallahassee, FL - Digital files for the upper, middle and lower Keys including: Monroe County Planning Group coverage; artificial reefs; John Pennekamp coverage and great white heron coverage.

Betsy Archer, NOAA/SEA Division, Rockville, MD - Digital data of the upper, middle, and lower Keys coverages. These data are being used in the COMPAS project.

Patrick Wells, Florida Park Service, Islamorada, FL - Map (1:90,000 scale) of the Lignumvitae Aquatic Preserve.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - One-minute grid of the Florida Keys area.

Jim Stillwell, City of Punta Gorda, Punta Gorda, FL - Information on the mapping of land cover data for the Charlotte Harbor area in 1982.

Tom Matthews, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Six maps that reflect boat densities for the following time periods: weekdays; weekends; July 4th, federal lobster season; state lobster season; and regular lobster season.

Dr. Gray Multer, Multer and Associates, Arkport, NY - Map depicting the Keys benthic resources, the Florida Keys National Marine Sanctuary and all other park borders, 1 degree graticule, geologic systems. These data will be used in a pamphlet to educate citizens on the importance of marine habitat and the relationship to the fisheries.

Jane Urquhart-Donnelly, Florida Department of Natural Resources, Bureau of Aquatic Preserves, Tampa, FL - Resource Impact Map of the Tampa Bay area.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Series of five maps of the Florida Keys National Marine Sanctuary featuring each of the benthic communities.

Charles Pittinger, Proctor and Gamble, Cincinnati, OH - Information on mapping submerged aquatic vegetation in Florida. Proctor and Gamble is the owner of a pulp mill in Perry on the Fenholloway River. They are required by FDER to photograph and map submerged aquatic vegetation.

Tom Matthews, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Nine maps depicting boat densities in the Florida Keys. Three maps featured fishing boats, dive boats (pre-July 25), and dive boats (post-July 25) densities.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Digital data including: benthic habitats; enhanced TIGER files; bathymetry; and shoreline for the Florida Keys National Marine Sanctuary.

J. Jackson, Church/Environmental Group, Orlando, FL - Seagrass information on the Fenholloway River.

Dr. Mark Lindberg, Department of Geography, University of South Florida, Tampa, FL - Aerial survey data and boat use sampling strategy for assessment of the method.

Eva Marie Koch, U.S. Geological Survey, Center for Coastal Geology, St. Petersburg, FL - Provided posters of trend analysis for display at a workshop for Congressmen from Washington, D.C.

Pamela McVety, Florida Department of Natural Resources, Tallahassee, FL - Boundary map for Little Manatee River.

Vic Klemas, University of Delaware, Wilmington, DE - Review classification for wetlands.

Joel Jackson, City of Tampa, Tampa, FL - Review Tampa Bay 1982 data, printed a 1:100,000 wax thermal of TP1982TND.GIS (15 sheets).

John Taylor, Taylor Biological Company, Inc., Panama City, FL - Eleven thermal wax prints (8 1/2" x 11") of St. Andrew Bay Preserve for CARL application for the Magnolia Beach Tract.

Walter Jaap, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Information on coral reefs near Boca Chica and Western Sambo Reef off Key West, displayed area and hectares in each polygon.

John Hunt, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Benthic community data for the FKNMS.

Stu Marvin, Environmental Planner, Hillsborough County City-County Planning Commission, Tampa, FL - Information on trends in seagrass distribution in Cockroach Bay.

Roy Lubke, Professor, Rhodes University, Grahamstown, South Africa - Information on GIS and marine resource mapping and monitoring in Florida.

Ben Randall, National Wetlands Research Center, U.S. Fish & Wildlife Service, Slidell, LA - Information on basinwide management, remote sensing, the use of remote sensing to access estuarine habitats, and the federal coastal wetland mapping programs.

Charles McShane, Printer, McShane and Moore, Tampa, FL - Black and white separates to be used in the printing of the Tampa Bay Boater's Guide.

Georgia Cranmore, Florida Marine Fisheries Commission, Tallahassee, FL - Provided 30" contour maps of St. Andrew's Bay, Biscayne Bay, and the Florida Keys.

Bob Wasno, Lee County Department of Community Services, Division of Marine Sciences, Fort Myers, FL - Slide of Little Manatee River fish distribution and Resource Impact Map of Charlotte Harbor.

Wayne Small, University of South Florida, Tampa, FL - Presentation and tour to inform students on topics pertaining to remote sensing, GIS, and current marine research.

Walter Jaap, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Digitized a coverage depicting the damaged area (due to boat grounding) of reef near Western Sambo and overlaid the coverage over the benthic database and plotted at a very detailed scale.

Dr. Don Hayward, Mote Marine Laboratory, Sarasota, FL - Supplied a disk of a conversion utility program for use in ongoing contracted Mote project.

Roger Johansson, City of Tampa, Department of Sanitary Sewers, Tampa, FL - Calculated areas of Tampa Bay, Old Tampa Bay, Hillsborough Bay, Lower Tampa Bay, and west of the Skyway Bridge.

William M. Davis, Pinellas County Board of County Commissioners, Clearwater, FL - Provided Tampa Bay Resource Impact Map.

Bill Harding, The Nature Conservancy, Naples, FL - Information on ARC\INFO and ERDAS applications software in mapping marine habitat.

Maynard Hiss, Sarasota, FL - Provided a thermal wax print of Sarasota County to exhibit at an administrative hearing concerning the Comprehensive Plan for Sarasota County.

Don Lord, Pinellas County Department of Communication and Information Systems, Clearwater, FL - Provided a plot of existing Tampa Bay Resource Impact Map to illustrate some of the data sets in the MRGIS.

Peter Clark, Tampa Bay Regional Planning Council, Agency on Bay Management, St. Petersburg, FL - Tampa Bay Resource Impact Map.

J. M. Kapetsky, Inland Water Resources and Aquaculture Services, Rome, Italy - Information on marine resources, GIS, shrimping, and habitat impact.

Bruce Ballister, Student, Florida State University, Tallahassee, FL - Provided information on coastal changes using aerial photography.

Tom Matthews, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Maps of boat use patterns in the Florida Keys using aerial surveys.

George McElvey, Florida Marine Fisheries Commission, Tallahassee, FL - Provided Tampa Bay Resource Impact Maps.

Robert D. Woodward, III, Florida Marine Fisheries Commission, Tallahassee, FL - Resource Impact Map of the Pensacola area.

Dr. Hugh Putnam, Water and Air Research, Inc., Gainesville, FL - Shipwreck plot of existing file and additional file with data for explosive testing study.

Dr. Pamela Hallock-Muller, University of South Florida, St. Petersburg, FL - Presentation to class on Florida Geology.

Ken Haddad, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Provided ten Resource Impact Maps (five of Biscayne and five of the Florida Keys).

Marion Eslich, Suncoast Seabird Sanctuary, Indian Rocks Beach, FL - Information on seagrass trend analysis and habitat trends and fisheries in Tampa and Sarasota Bays.

Dr. Joseph Kimmel - Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Copy of low-flying aerial survey of Dry Tortugas, FL for a reference for habitat maps to aid in the selection of fish counting sites.

Lyman Barger, Fishery Biologist, NOAA/National Marine Fisheries Service, Panama City, FL - Two sets of photographs of Warren Bayou, one from 1980 EPA study and two 1983 NHAP color infrared.

Dr. Joseph Kimmel, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Benthic coverage of resources in the Dry Tortugas (1:24,000).

Kent Smith, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Information on mapping of marine habitat for the state of Florida.

Nanette Holland, Reporter, Tampa Tribune, Tampa, FL - Photography for news article on propeller scar damage to seagrass beds.
Carol Blackwell, NOAA/SEA Division, Rockville, MD - Two copies of Biscayne Bay Resource Impact Map and two of the Florida Keys.

William M. Davis, Pinellas County Board of County Commissioners, Clearwater, FL - Tampa Bay Resource Impact Map.

Joan Browder, NOAA/National Marine Fisheries Service, Miami, FL - Reprints on marine habitat mapping and fisheries research from the MRGIS.

Ellen Anderson, U.S. Geological Survey, Center for Coastal Geology, St. Petersburg, FL - Copy of Big Bend GIS and Trailer file from server to tape to be used as ancillary data for their project monitoring changes in the Florida Gulf coast wetlands between Tampa and Tallahassee.

Harry Grier, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Photographs and information about photograph enlargement for Bishop Harbor for mapping of the habitat.

Dr. Clinton Dawes, University of South Florida, Tampa, FL - Information about mapping and propeller scar damage in Cockroach Bay.

Gary Milano, Dade County Department of Environmental Resources Management, Miami, FL - Provided Marszalek map #1 for review in Dade County.

Robert Steward, Department of Marine Science, University of South Florida, St. Petersburg, FL - Resource Impact Maps of Tampa Bay, Charlotte Harbor, Florida Bay, Everglades, and Dry Tortugas.

Brad Robbins, Student, University of South Florida, Tampa, FL - Conducted tour of facility and gave information on seagrass mapping and aerial photography.

Richard Newfield, St. Petersburg Area Chamber of Commerce, St. Petersburg, FL - Presented a slide show for Career Day at Northeast High School.

William Teehan, Florida Marine Fisheries Commission, Tallahassee, FL - Provided Charlotte Harbor Resource Impact Map for public hearing.

John Marcellus, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plot of seagrass data from their database of Bishop's Harbor for use of survey of red drum habitats and movements within the bay.

Stephen M. Hodges, Homer Hoyt Center for Land Economics and Real Estate, Florida State University, Tallahassee, FL - Information on marine resources.

Ben Haskill, NOAA/OCRM, Washington, D.C. - Plot of Resource Impact Map for the Florida Keys and Biscayne Bay.

Suzanne Yancy, Teacher, Olympic Heights Community High School, Boca Raton, FL - Provided plots of the Florida Keys and Biscayne Bay Resource Impact Maps and marine research brochures for use in 9th and 10th grade science classes.

John Marcellus, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Showed benchmark symbology grid network and tic shift on top quad sheets for Bishop's Harbor red drum study.

Kevin Peters, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Photographs of Emerson Point for review to determine enlargement feasibility for snook research area.

Peter Clark, Tampa Bay Regional Planning Council, St. Petersburg, FL - Provided wetland trend map of Tampa Bay, 1950 and 1982.

Harry Grier, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Reviewed aerial photograph enlargements for the Bishop Harbor area of Tampa Bay.

Doug Haymans, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Created a plot file using 1990 Tampa Bay seagrass data for a base map for a sampling project.

Walter Jaap, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Four maps (Dry Tortugas, Western Sambo, John Pennekamp Coral Reef State Park and Looe Key) for presentations at two scientific meetings.

Alice Bard, Florida Department of Natural Resources, Division of Recreation and Parks, Clermont, FL - Provided 1950 and 1982 land cover classifications of St. Joe Sound area.

Monroe County, Key West, FL - Review of coastal element of the Comprehensive Plan.

Tampa Bay Regional Planning, Council, Agency on Bay Management, St. Petersburg, FL - Map of seagrass propeller scar damage.

R. Duncan Mathewson, III, National Center for Shipwreck Research, Islamorada, FL - Created plot of shipwrecks in the Florida Keys.

Dr. James Miller, Florida Department of State, Division of Historic Resources, Tallahassee, FL - Shipwreck database and plot file for management of Florida's historic resources.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Plot of shipwrecks in the Florida Keys to aid in FKNMS management.

Dr. James Miller, Florida Department of State, Division of Historic Resources, Tallahassee, FL - Florida Keys and Tampa Bay Resource Impact Maps.

Jennifer Wheaton, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - 1982 seagrass map of Upper Tampa Bay (Anclote Key/Honeymoon Island area) for use in lease site inspection.

Gary Waters, Environmental Systems Research Institute, Inc. Charlotte, NC - Provided benthic resources, state boundary, sanctuary boundary, and shipwreck databases.

Ken Hartley, Shrimper, Pinellas Park, FL - Aerial photographs of Ft. DeSoto, Gulfport to Pinellas Point to study shoreline and bottom in detail.

Dr. Bob Hall, U.S. Environmental Protection Agency, San Francisco, CA - Reprints on mapping marine resources in Florida.

Will Davis, Pinellas County Environmental Management, Clearwater, FL - List of concerns for overflight mission to photograph propeller scars and seagrasses at Ft. DeSoto and gather information pertaining to aerial photography.

Clarita Lund, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Calculation of seagrass area for Indian River for hard clam distribution study.

Neil Burns, U.S. Environmental Protection Agency, Water Management Division, Atlanta, GA - Compile list of ARC/INFO databases for data exchange.

Doug Heatwole, Ecology & Environment, Tallahassee, FL - List of aerial photograph acquisition companies for statewide gas pipeline project.

Dr. Robert Aangeenbrug, Department of Geography, University of South Florida, Tampa, FL - Invited speaker for GIS class a the USF, St. Petersburg.

Walter Jaap, Jennifer Wheaton, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Review photographs and camera apparatus for accuracy in mapping coral growth.

Tom Ash, Hillsborough Environmental Protection Commission, Tampa, FL - Copies of aerial guidelines for propeller scar damage mapping.

Dr. Larry Doyle, Dean Milliken, Florida Institute of Oceanography, St. Petersburg, FL - Converted state plane coordinates to latitude/longitude and provided digital file of the coordinates.

Daryl Scherkenbach, Resource Data, Anchorage, AK - Copy of Florida shoreline to tape cartridge to provide sample data for oil spill application.

Christopher P. Jones, Applied Technology and Management, Inc., Charleston, SC - Thermal wax prints of Hurricane Pass (Honeymoon Island and Caladesi Island) from 1950 and 1982.

Dr. Robert Aangeenbrug, Department of Geography, University of South Florida, Tampa, FL - GIS class given tour and demonstration of MRGIS.

Tom Adams, Brevard Community College, Palm Bay, FL - Assist in setting up GIS base facility at Brevard Community College.

Kent Smith, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Seagrass distribution data.

Brad Stieh, Archbold Biological Station, Lake Wales, FL - Information on scanning aerial photography and digital images.

Dr. Larry Doyle, Department of Marine Science, University of South Florida, St. Petersburg, FL - Conversion of a series of state plane coordinates into latitude and longitude.

Jennifer Bexley, U.S. Geological Survey - Tampa, FL - Assist with aerial photography and allow use of the zoom transfer scope when available for project.

Peter Jernakoff, CSIRO, Australia - Reprints on the trends in coastal habitat mapping and monitoring.

Dr. Randy Parkinson, Florida Institute of Technology, Melbourne, FL - Information on salt marsh loss in Florida.

Mike Hoff, U.S. Fish and Wildlife Service, Ashland, WI - CZM conference material.

Patrick Jodice, Florida Game and Freshwater Fish Commission, Lake City, FL - Information on marine resources in the Tampa Bay area.

Neil Burns, U.S. Environmental Protection Agency, Water Management Division, Atlanta, GA - Digital data depicting boundary of FKNMS and Florida shoreline for the southern portion of the state in ARC/INFO export format.

Mark McClanahan, Student, Department of Geography, University of Florida, Gainesville, FL - Landsat TM imagery 15/41 Scene ID 4015115174 to study spatial diffusion and urban growth.

Eric Fisher, National Audubon Society, New York, NY - Information relating to habitat loss and ecosystem types for a biodiversity project.

Joe Santo, GEONEX, St. Petersburg, FL - Information on NOAA's cost of reproducing aerial photography of the Florida Keys.

Bob Virnstein, St. John's Water Management District, Palatka, FL - Reprints on seagrass mapping and monitoring, and seagrass distribution and abundance patterns.

Paula Houhoulis, University of Georgia, Athens, GA - Information on seagrass experiments in Weedon Island.

Ruth Folit, New College, Sarasota, FL - Information on propeller scar damage in seagrass beds.

Eric Fehrman, Pinellas County Department of Environmental Management, Clearwater, FL - Reviewed aerial photography for propeller scar damage.

Bill Porter, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Supplied computer information.

Richard Ring, Everglades National Park, Homestead, FL - Request to be involved in Florida Bay Interagency Working Group.

Juan A. Vega, U.S. Department of Agriculture, Soil Conservation Service, Palmetto, FL - 1:24,000 plot of soil database at Hillsborough and Manatee County line.

Doug McLain, NOAA, Monterey, CA - Information on the marine resources mapping and monitoring in Florida, habitat trends in Tampa and Sarasota Bays, and a MRGIS summary.

Bruce Bauer, Breedlove, Dennis & Associates, Inc., Orlando, FL - Reprints on marine resource mapping and monitoring in Florida and the role of GIS in mapping Florida's coastal wetland resources.

Ruth Roaza, Florida Department of Environmental Regulation, Tallahassee, FL - Tour and demonstration of the MRGIS.

Joe O'Hop, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plot of keygroups at a large scale to help assign fish dealers to groups.

Kathy Swanson, Florida Department of Natural Resources, Bureau of Sanctuaries and Research Reserves, FL - Digital data featuring polygons coded for reefs in the Florida Keys exported as single precision.

Bill Porter, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Digital coverage Florida shoreline base map.

Kathy Nesmith, Florida Natural Areas Inventory, Tallahassee, FL - Plotted out print data on a map of south Florida titled "Florida Natural Areas Inventory South Florida Element Occurrence Locations June 1992."

Jane Urquhart-Donnelly, Florida Department of Natural Resources, Florida Marine Patrol, Tampa, FL - Map showing resources in area of oil spill drill. Resources acreages within the spill boundary were calculated.

Holly Greening, Tampa Bay National Estuary Program, St. Petersburg, FL - Digital database of 1950 Tampa Bay land cover.

Doug Haymans, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plot of Tampa Bay depicting three zones: Bishop's Harbor, MacDill and Weedon Island, and all of Manatee River (showing Safety Harbor) at 1:100,000.

Joe O'Hop, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Import keygroup file and plot keygroups with land and FKNMS boundary (COMPAS).

Mary Beth Regan, Reporter, Orlando Sentinel, Orlando, FL - Slides showing damage to mangroves after Hurricane Andrew for the Everglades and Paradise

Point areas.

Mary Morris, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Plot out and assemble a boat sampling atlas. Plot out two maps (state lobster and federal lobster seasons) that show collected data.

Billy Causey, NOAA, Marathon, FL - Large-scale map to display the entire Keys in some form of tile scheme. Map displays bathymetry, benthic resources, navigational aids, boundaries, and zoning.

Skip Snow, Everglades National Park, Miami, FL - Digital data in ARC/INFO export format of benthic habitat data.

May Zaitoon, Alghanim Industries, New York, NY - Compiled a variety of statistics and information regarding the Florida Keys marinas and recreational facilities for a group of international investors interested in the Florida Keys.

John Hunt, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Provided one complete atlas of boating survey maps.

George Jones, John Pennekamp Coral Reef State Park, Key Largo, FL - Provided copy of aerial video for a documentary shown on Channel 2 in Miami.

Cynthia Elder, Broward County, Office of Natural Resources Protection, Marine Resources, Fort Lauderdale, FL - Provided information of inventory of GIS coverages to provide advise on oil spill contingency planning and GIS.

Bill Porter, Florida Department of Natural Resources, Office of Protected Species Management, Tallahassee, FL - Provided copy of CalComp shade set and a statewide 5-minute grid.

Margit Crowell, South West Florida Water Management District, Brooksville, FL - Provided CalComp shade set for use in developing GIS maps.

Vince Sclafani, National Wetlands Research Center, Lafayette, LA - Digital files for creating paper plots using the electrostatic plotter.

Tom Marlow, FEMA, Miami, FL - Digital data of Florida shoreline, Florida county, and 5-minute grid files in ARC/INFO format to be used for Hurricane Andrew recovery.

Patty Sime, South Florida Water Management District, West Palm Beach, FL - Digital National Wetlands Inventory coverages for the Florida Keys quads.

Gary J. Reckner, U.S. Department of Agriculture, Soil Conservation Service, Sarasota, FL - Landsat photocopy for seminar.

Dr. Churchill Grimes, NOAA/National Marine Fisheries Service, Panama City, FL - Landsat imagery.

Paul Carlson, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plots of 1:24,000 quad scale of seagrass and marsh data in St. Joe Bay to estimate seagrass loss.

David Camp, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plot of benthic community database for south Florida.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Plot of most desirable color palette for modifying the colors of the "War Room" map of the Florida Keys and a plot of some available line types and weights.

Mike Salcedo, Florida International University, Miami, FL - Loaned 36" x 36" enlargements of Hurricane Andrew with a text summary of the photographs.

Dale Rubin, Dale Rubin Design Associates, Breesport, NY - Plot of Florida Keys habitat map originally done for Dr. Multer in September 1992.

Virginia Shepherd, Eckerd College, St. Petersburg, FL - Plot of Tampa Bay featuring mangroves and seagrasses from the 1989/1990 Florida land use-land cover database.

Betsy Archer, NOAA/SEA Division, Rockville, MD - Digital data featuring bathymetry (3, 6, 12 ft depths) within the Florida Keys National Marine Sanctuary.

M. Marshall, Mote Marine Laboratory, Sarasota, FL - Use of remote sensing to access estuarine habitats and machine processing of remotely sensed data.

Daniel Williams, Architect, We Will Rebuild, Miami, FL - Loaned photographs of Hurricane Andrew for a presentation.

Steve Schropp, Taylor Engineering, Jacksonville, FL - Background information on seagrass mapping of Indian River Lagoon for National Estuary Program RFP for mapping historical seagrass data.

Dr. Joseph Kimmel, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Map of Florida Keys benthic communities.

Brian Julius, NOAA/Damage Assessment, Rockville, MD - Analysis of south Florida benthic community database for the Grecian Rocks area.

George Henderson, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Two plots that are good examples of work CAMRA does to show numerous coverages.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Digital data of Aids to Navigation database for the upper, middle, and lower Keys and an explanation of bathymetry codes.

Walter Jaap, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Sampling map for Fort Jefferson National Monument, Dry Tortugas for ecosystem meeting in Miami.

Diane Richards, Geography Club, University of South Florida, Tampa, FL - Several maps as examples of work done using GIS.

Nick Toth, Florida Department of Natural Resources, Cockroach Bay Aquatic Preserve, Tampa, FL - Map of marine resources for the Cockroach Bay Aquatic Preserve.

Jorge Laguna, Florida Marine Fisheries Commission, Tallahassee, FL - Reprints on seagrass distribution, potential of Landsat imagery for assessing fisheries habitat, and marine resource mapping and monitoring.

Barry Lenz, Dames & Moore, Tampa, FL - Conversation about aerial photography of seagrass distribution.

Mike Wessel, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Aerial photography of Cedar Key/Crystal River area to review oyster beds and boat ramps.

James Robeson, Florida Department of Environmental Regulation - GPS coordinate data for use in a test of GPS in Florida.

Robert Finegold, NOAA/FKNMS, Marathon, FL - Copy of Marszalek habitat definitions to calculate habitat acreages.

George Barley, NOAA/FKNMS, Orlando, FL - Satellite photographs of Hurricane Andrew and pre-1986 Landsat imagery.

Louis Marcotte, Canada Centre for Remote Sensing, Ottawa, Ontario, Canada - Reprints on marine wetland mapping and monitoring in Florida.

Dr. Charles W. Finkl, Department of Geology, Florida Atlantic University, Boca Raton, FL - Landsat TM imagery to test land use land cover classification system.

Gordon Thayer, NOAA/National Marine Fisheries Service, Beaufort, NC - Consultation regarding aerial photography for Florida Bay, specifically in the area of Johnson Key and Man-O-War Keys. Advised him the photographs for that area to the west are uninterpreted.

Scot Smith, University of Florida, Gainesville, FL - Post-hurricane Andrew TM imagery for an impact study.

Peter K. Gottfried, Natural Systems Analysts, Winter Park, FL - 7" x 7" print of TM data for Pithlachascotee River (Pasco County).

Lyman Barger, Fishery Biologist, NOAA/National Marine Fisheries Service, Panama City, FL - St. Andrew Bay Resource Map coverages and plot.

Peggy Mathews, Florida Department of Environmental Regulation, Tallahassee, FL - Twenty-one slides of seagrass meadow die-off, algal blooms, epiphytic growth on seagrass, dead mangroves, resource map, sponge die-off.

Dr. Gustavo Antonini, University of Florida, Gainesville, FL - Digital export files of bathymetry coverage contained on chart numbers 11463, 11465, and 11467.

George Henderson, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Plot of Tampa Bay oil spill drill.

Stephen Stetson, American Forests, Chris Daniel, Comp-Tron, Baltimore, MD - Information from Hurricane Andrew in 8 mm digital format.

Allen Foley, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Create turtle coverage with the following items: latitude/longitude, date, species, and size.

Judy Ott, Florida Department of Natural Resources, Southwest Florida Aquatic Preserves Office, Bokeelia, FL - Blueprint of eight quads from the 1983 Charlotte Harbor land use and vegetation maps.

Bill Zace, Monroe County, Key West, FL - Plot featuring benthic communities and selected managed areas for south Florida and Florida lobster season map.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Map showing benthic resources with zoning alternative III areas within the Florida Keys National Marine Sanctuary.

J. Dobson, Oakridge Laboratory - Shortened version of COASTWATCH papers form ASPRS/RT 1992.

Dr. Gray Multer, Multer and Associates, Arkport, NY - Plotted two copies of the SEAKEYS map and one mylar separate.

Glen Woodson, Environmental Consultant, Tallahassee, FL - Consultation regarding all aspects of seagrass mapping from equipment, aerial photographs to classification and field work.

Cheryl Young, Chiles Communication, Tallahassee, FL - Copy of CAMRA GIS summary.

Kathy Swanson, Bureau of Sanctuaries and Research Reserves, Florida Department of Natural Resources, Tallahassee, FL - Plot out a boat user atlas.

Dr. John R. Jensen, Department of Geography, University of South Carolina, Columbia, SC - Review comments on development of an Everglades vegetation map using SPOT imagery and GPS coordinate data.

Bob Repenning, Florida Department of Natural Resources, Southwest Florida Aquatic Preserves Office, Bokeelia, FL - 35 mm slides of propeller scar damage in southwest Florida.

K. Lollar, New Press, Fort Myers, FL - Slides of specific propeller scar damage to seagrass between Naples and Boca Grande. Also provided underwater photographs and an interview.

Nanette Holland, Reporter, Tampa Tribune, Tampa, FL - Seagrass propeller damage management and education information.

Dale Patchett, Florida Department of Natural Resources, Tallahassee, FL - Information on seagrass distribution in Delray Beach, Florida.

Betsy G. Davis, HDR Engineering, Inc., Tampa, FL - Large-scale map of seagrass and marsh data in Escambia and Blackwater Bays.

Carol Patterson, Florida Department of Natural Resources, Florida Marine Patrol, Jacksonville, FL - Jacksonville Resource Impact Map.

Dr. Gray Multer, Multer and Associates, Arkport, NY - Changes made to the map featuring benthic communities inside the Florida Keys National Marine Sanctuary (SEAKEYS).

Marty Armstrong, Armstrong Environmental - Information for the National Estuary Program (NEP) and Submerged Aquatic Vegetation (SAV) in the Tampa Bay area.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Forty-two maps showing benthic communities in the Florida Keys for use by the FKNMS Advisory Council.

Sid Flannery, Southwest Florida Water Management District, Brooksville, FL - Revised calculations for water table depth (low) and water table depth (high) for each gaged unit of the Little Manatee River watershed.

Wei Ji, NWRC/Spatial Analysis Branch, Lafayette, LA - Provided a copy of the oil spill RFP and ESRI legislation.

Ken Haddad, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Modified SEAKEYS map showing three more managed areas, Coupon Bight, Lignumvitae, and Biscayne Bay for the Florida Bay interagency advisory committee meeting.

Gary J. Reckner, Sarasota Soil & Water Conservation District, Sarasota, FL - Information on how to obtain image of Sarasota County and surrounding area.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Copy of Tom Matthews data in digital format for NOAA mapping for FKNMS management plan.

Louis Coakley, Florida Power & Light, North Palm Beach, FL - Information on our Automated Oil Spill Sensitivity Atlas being developed by the Department.

Jordan Hines, The Nature Conservancy, Key West, FL - Copy of the boat survey atlas.

Mary Hoppe, Tampa Bay National Estuary Program, St. Petersburg, FL - Updated boat ramp database for the Tampa Bay Boater's Guide.

Michael E. Cressey, State of Maine Department of Environmental Protection, Augusta, ME - Information on COMPAS.

Steve Otwell, James Cato, SeaGrant, University of Florida, Gainesville, FL - Presentation to the North Florida Fly Fishers.

Marsha Martin, Lake Michigan Construction Company, Naples, FL - Resource Impact Map which identifies the benthic resources in the Naples, Florida area.

Nicholas W. Klobuchar, Tampa, FL - Toured the facility and requested a listing of the ARC/INFO User's Group roster.

Scott Taylor, Florida Natural Areas Inventory, Tallahassee, FL - Draft copy of a map depicting the boundaries of selected managed areas within the Florida Keys National Marine Sanctuary in DXF format.

Dr. Gustavo Antonini, University of Florida, Gainesville, FL - Hurricane Andrew aerial photographs.

John Hunt, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - May 1992 TM image and transparency of Florida Bay showing turbid water and May 1989 image showing clear water. November 1992 and January 1993 airplane survey of Florida Bay with colored areas showing phytoplankton bloom.

George Barley, NOAA/FKNMS, Orlando, FL - May 1992 TM image and transparency of Florida Bay showing turbid water and May 1989 image showing clear water. November 1992 and January 1993 airplane survey of Florida Bay with colored areas showing phytoplankton bloom.

Mark Robertson, The Nature Conservancy, Key West, FL - May 1992 TM image and transparency of Florida Bay showing turbid water and May 1989 image showing clear water. November 1992 and January 1993 airplane survey of

Florida Bay with colored areas showing phytoplankton bloom.

Betsy Archer, NOAA/SEA Division, Rockville, MD - 3 ft and 12 ft bathymetric data for three areas to add to COMPAS database.

William Teehan, Florida Marine Fisheries Commission, Tallahassee, FL - Big Bend Resource Impact Map with 3-mile line and new shrimp zones.

James McKenna, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Developed a hypsographic curve of Tampa Bay.

Allen Foley, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Determine latitude and longitude of three marine turtle strandings in Pinellas County and add into database.

Mark Butler, Old Dominion University, Norfolk, VA - Slides of Florida Bay showing phytoplankton bloom.

Linda Salisburg, Sarasota Herald-Tribune, Port Charlotte, FL - Two Landsat TM (EARTHSAT) prints of Charlotte Harbor.

Bob Thompson - Florida Department of Natural Resource, Bureau of Marine Resource, Regulation and Development, Tallahassee, FL - 1989 Indian River seagrass map.

Peter Allen, Everglades National Park, Flamingo, FL - May 1992 TM image and transparency of Florida Bay showing turbid water and May 1989 image showing clear water. November 1992 and January 1993 airplane survey of Florida Bay with colored areas showing phytoplankton bloom.

Alan Farago, FLX Communications, Miami, FL - Information on Florida Bay water quality. Sent four slides and thermal wax print of Florida Bay.

Tom Matthews, Florida Department of Natural Resources, Florida Marine Research Institute, Marathon, FL - Plot of new data points and add buoys to boat sampling atlas.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - ARC/INFO export file of the latest south Florida benthic resources database.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Final version of the south Florida benthic resource map with no zones on it, and a map of the Florida Keys boat sampling atlas.

Dr. Gustavo Antonini, University of Florida, Gainesville, FL - Tiger data file and NWI data file.

Dr. Cathy Parker, Department of Geography, University of Georgia, Athens, GA - Information on aerial photographs for mapping stands of sand pines.

Rod Hefling, Haff and Daugherty Graphics, Hialeah, FL - Provided Postscript file for SEAKEYS map.

Dr. Gray Multer, Multer and Associates, Arkport, NY - Modifications to the SEAKEYS map.

Bob Mulcahy, Continental Shelf Associates, Jupiter, FL - Draft maps of explosive testing plots in support of Phase II of site selection for explosive testing in the Florida Keys.

Phil Steele, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Modifications to the Big Bend Resource Impact Map for the Florida Marine Fisheries Commission meeting. Calculated acreages for all zones.

Scott Taylor, Florida Natural Areas Inventory, Tallahassee, FL - Export file of 1:40,000 Florida shoreline to set up their GIS.

Randy Imai, California Department of Fish & Game, Office of Spill Prevention and Response, Sacramento, CA - Copy of Florida Keys boat sampling atlas to help California design an atlas to be used by the primary on-scene coordinator.

Dr. Mark Lindberg, Department of Geography, University of South Florida, Tampa, FL - Provided small coverage to test importing ARC 6.1 coverages into ARCVIEW.

Anne Meylan, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Tampa Bay Resource Impact Map to assist in writing MARFIN grant proposal. Provided reprint of GIS and fisheries management.

Dave Crewz, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Map showing mangroves in Tampa Bay to be used as a display tool to show Japanese scientists the mangrove distribution and extent.

Michael E. Cressey, State of Maine Department of Environmental Protection, Augusta, ME - Provided a copy of marine facilities questionnaire to assist them in setting up a marine facilities database.

Jill Peterson, NOAA, Seattle, WA - Provided a copy of marine facilities questionnaire to assist them in setting up a marine facilities database.

Peter Comeau, Collier County Government, Naples, FL - Requested all data in the system for Collier County.

Anne Meylan, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Three copies of the Big Bend Resource Impact Map to be included in a MARFIN grant proposal for turtle research.

Carol Blackwell, NOAA/SEA Division, Rockville, MD - Bathymetry coverage of the Florida Keys.

Rita Meng, Major Green, Florida Department of Natural Resources, Florida Marine Patrol, Tampa, FL - Tour of the facility.

Mark Provancha, Bionetics, Kennedy Space Center, Kennedy Space Center, FL - Information on UNIX system administration.

Clive Howard, Dale Rubin Design Associates, Breesport, NY - Provided copy of SEAKEYS map.

Bob Potter, McShane and Moore, Tampa, FL - Corrections to the Tampa Bay National Estuary Program Tampa Bay Boaters' Guide.

Margit Crowell, South West Florida Water Management District, Brooksville, FL - Provided water table depth (low) and permeability type coverages from the Little Manatee River watershed database in ARC/INFO export format.

Skip Snow, Everglades National Park, Homestead, FL - ARC/INFO coverages of various "managed areas" in the Florida Keys.

Hans Zarbock, Coastal Environmental, Inc., St. Petersburg, FL - Waste-water service areas map.

Hans Zarbock, Coastal Environmental, Inc., St. Petersburg, FL - List of septic tank densities by section-township-range for the Little Manatee River watershed.

Jazek Balszczynski, Bureau of Land Management, Boulder, CO - Information about the FKNMS Benthic Mapping Program. Provided a map (8 1/2" x 11") of the Sanctuary.

Mike Johnson, Florida Department of Natural Resources, Florida Marine Research Institute, Inglis FL - Big Bend Resource Impact map showing seagrasses from the Lower Suwanee to the Homasassa River area.

Dr. Kathleen Sullivan, University of Miami, FL - Tour of facility and demonstration of MRGIS.

Dr. Kendall Carder, Department of Marine Science, University of South Florida, St. Petersburg, FL - Tour of MRGIS and demonstration of remote sensing and GIS techniques for graduate Hyperspectral Remote Sensing class.

Toy Livingston, Department of Consumer Affairs, Tallahassee, FL - Reprints on seagrass distribution and Florida marine fisheries habitat.

Mike Incze, Naval Undersea Warfare Research & Development Laboratory, Rhode Island - Information on marine resources and GIS particularly with respect to oil spill applications.

Don Carter, Fry, Hammond & Barr, Orlando, FL - Developed eight scenes of western Florida Bay area depicting variations on position of phytoplankton bloom and discolored water. Eight thermal wax prints and eight slides were produced.

Estus Whitfield, Office of the Governor, Environmental and Community and Economical Development Policy Unit, Tallahassee, FL - Transparency images of Florida Bay depicting phytoplankton blooms and discolored water.

Ray L. Harris, Department of Geography and Environmental Studies, San Jose State University, San Jose, CA - Reprints related to GIS and coastal zone management.

Dr. Sandy Vargo, Florida Institute of Oceanography, St. Petersburg, FL - Copy of thermal wax print of phytoplankton bloom in Florida Bay to assist in writing grant proposal.

Phil Steele, Florida Department of Natural Resources, Florida Marine Research Institute, St. Petersburg, FL - Two Big Bend Resource Impact Maps for Florida Marine Fisheries Commission meeting.

Sally Patrenos, Bureau of Seafood & Aquaculture, Tallahassee, FL - Information regarding water quality of Florida Rivers.

John Couy, Private Citizen, Punta Gorda, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune.

Ken Hartley, Shrimper, Pinellas Park, FL - Lent 2 thermal wax prints and 4 maps of the Honeymoon Island - Caladesi Island area.

Gary Vandenberg, Scientific Support Coordinator, NOAA, Miami, FL - Export file of Florida shoreline to aid in developing an oil spill response plan.

Charles G. Brown, II, Charlotte State Bank, Port Charlotte, FL - Duplicate of Charlotte Harbor TM slide that appeared in an article in the Sarasota Herald Tribune.

Margaret Harmon, Private Citizen, Punta Gorda, FL - Duplicate of Charlotte Harbor TM slide that appeared in an article in the Sarasota Herald Tribune.

Lucille Fenton, Atlantic Gulf Communities, Port Charlotte, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune. The enlargement will be used for the Welcome Center Office in Port Charlotte.

C.T. Klein, Port Charlotte, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune.

William G. Haerr, Private Citizen, Nokomis, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune.

Charles Eastwood, Private Citizen, Venice, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune.

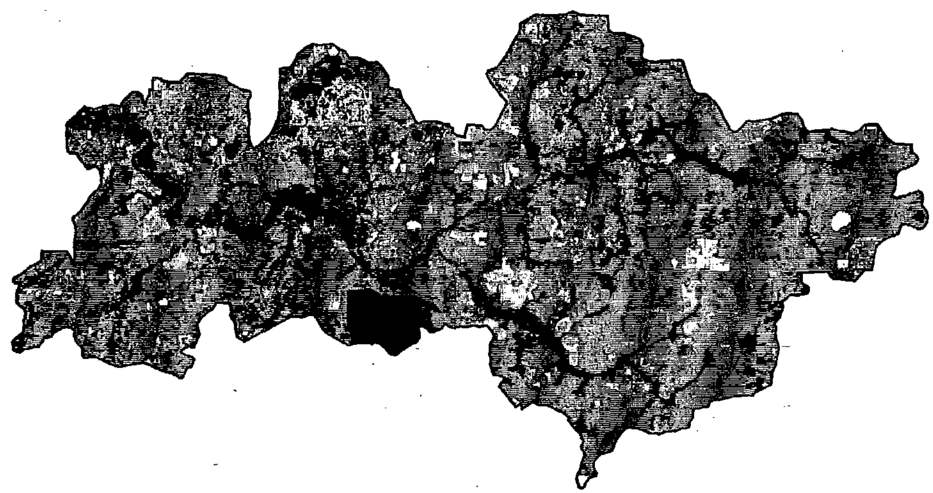
John Blaser, Blaser's Nurseries, Inc., Tallevast, FL - Duplicate of Charlotte Harbor Landsat TM slide that appeared in an article in the Sarasota Herald Tribune.

REFERENCES

Doolittle, J.A., G. Schellentrager, and S. Ploetz, 1989. Soil Survey of Hillsborough County, FL., United States Department of Agriculture, Soil Conservation Service, 168 pp.

Flannery, M.S., H.C. Downing, Jr., G.A. McGarry, and M.O. Walters, 1991. Increased nutrient loading and baseflow supplementation in the Little Manatee River Watershed, pp. 369-395 in S.F. Treat and P.A. Clark, eds. Proceedings of the Tampa Bay Area Scientific Information Symposium II, 528 pp.

Little Manatee River Watershed Atlas



Florida Department of Natural Resources

A report of the Florida Department of Community Affairs
pursuant to
National Oceanic and Atmospheric Administration Award No. NA270Z0345-01

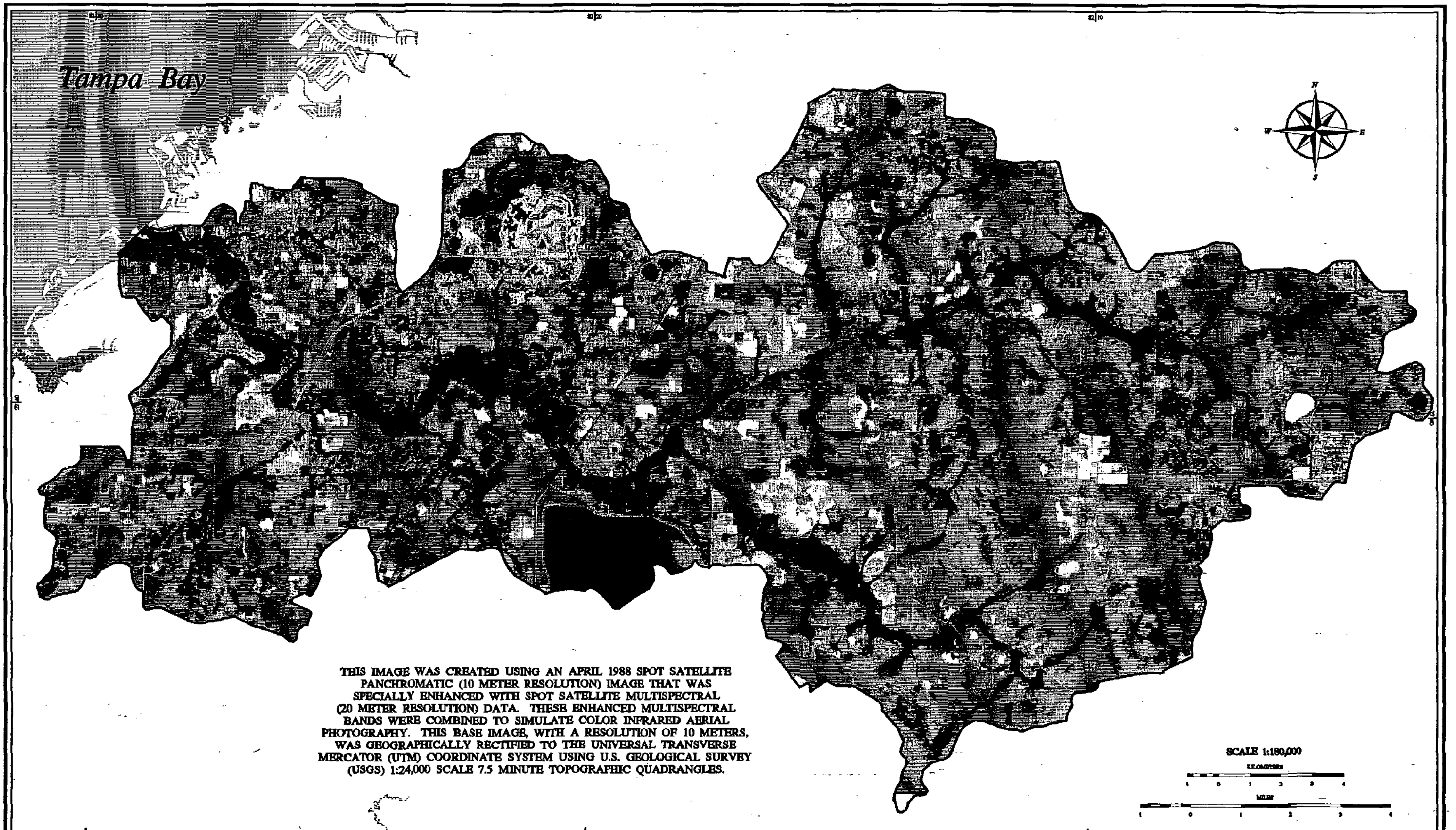
The Little Manatee River (LMR) watershed, located on the eastern shore of Tampa Bay, Florida, was selected as the site of a multi-agency project focusing on the development of watershed-oriented resource-management tools and strategies. The project was a cooperative effort by federal, state, regional, and local agencies. The LMR watershed includes 36 subbasins that drain 573 square kilometers of land covering portions of two counties. The dominant land use in the watershed is agricultural. The recently completed Interstate-75, however, provides a major corridor for influx and growth and will undoubtedly impact a significant portion of the watershed.

Using the Marine Resources Geographic Information System (MRGIS) at the Florida Department of Natural Resources Florida Marine Research Institute in St. Petersburg, we, through a multi-agency effort, have developed a comprehensive database for the watershed. The maps featured in this atlas represent a portion of that database. The following data layers are included in this atlas: SPOT satellite basemap, land cover 1988, flood zones, wildlife plant communities, future land use, elevation, distribution of selected species of fish, detailed soils, soil hydrologic units, locations of wastewater treatment facilities, withdrawal sites of permitted wells, and densities of septic tanks based on section-township-range. The transportation network, subbasins, hydrologic gaged boundaries, hydrology, and section-township-range units are shown as mylar overlays. In addition, a 500-ft buffer has been calculated for the river corridor and is shown as an overlay. The results of a GIS analysis are demonstrated in the map describing future land use within the 100 year flood zone. For this analysis, we identified the 100 year flood zone on the basis of the flood zone data. We then evaluated these flood-prone areas based on the future land use map.

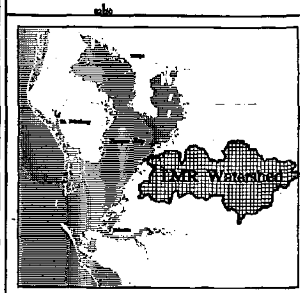
All map sheets and mylar overlays are co-registered to allow real-time analysis of the map pages. We encourage users of this atlas to explore the relationships among the map layers by removing the mylar overlays and superimposing them onto the thematic coverages.

This atlas is designed to provide a general view of the watershed and the relationships among the different types of information. The detailed digital information can be made available to agencies with GIS capabilities. For additional information on the Little Manatee River watershed database, or this atlas, please contact:

Gail McGarry MacAulay
Florida Department of Natural Resources
Florida Marine Research Institute
100 Eighth Avenue SE
St. Petersburg, FL 33701
(813) 896-8626



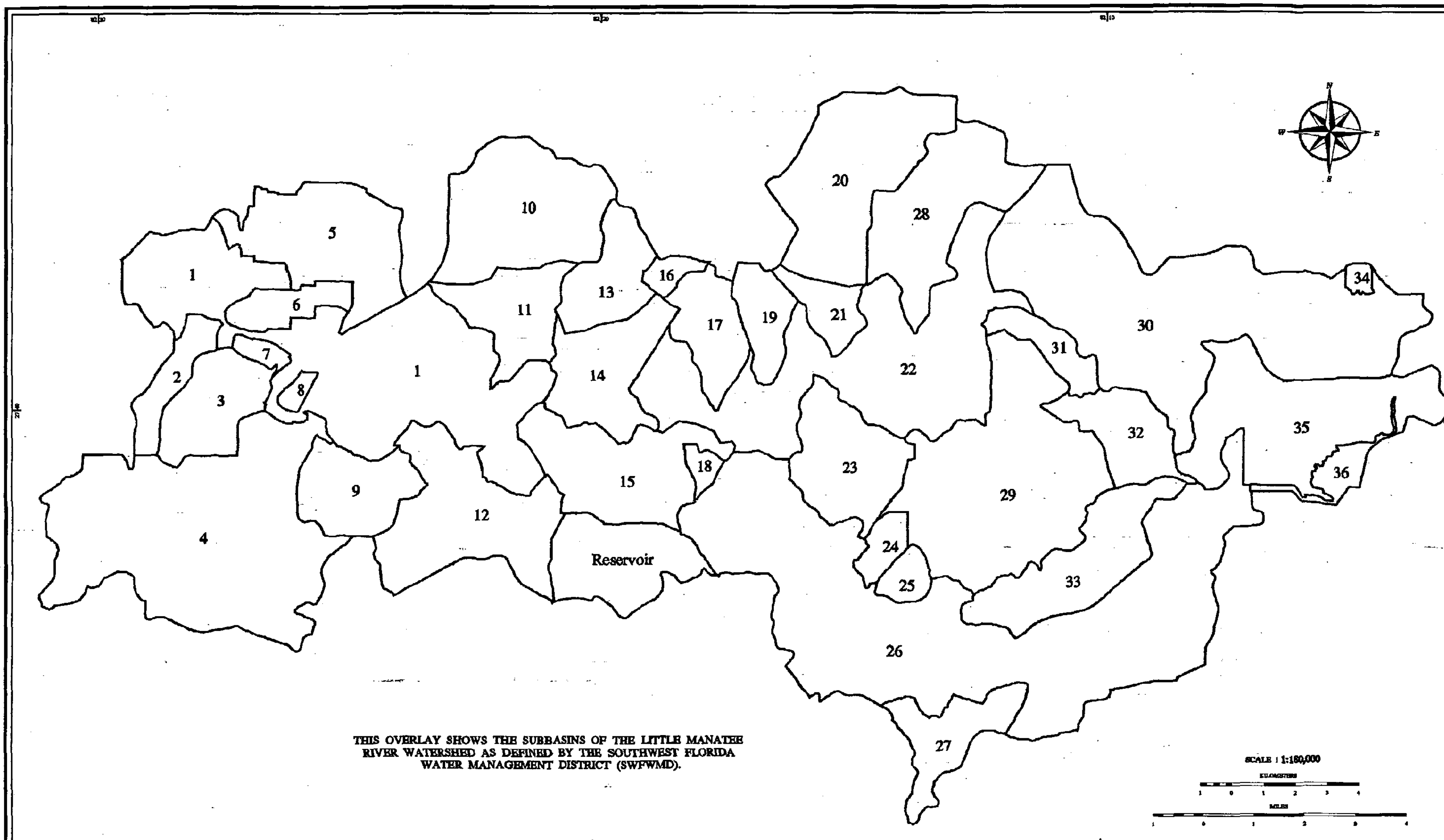
THIS IMAGE WAS CREATED USING AN APRIL 1988 SPOT SATELLITE PANCHROMATIC (10 METER RESOLUTION) IMAGE THAT WAS SPECIALLY ENHANCED WITH SPOT SATELLITE MULTISPECTRAL (20 METER RESOLUTION) DATA. THESE ENHANCED MULTISPECTRAL BANDS WERE COMBINED TO SIMULATE COLOR INFRARED AERIAL PHOTOGRAPHY. THIS BASE IMAGE, WITH A RESOLUTION OF 10 METERS, WAS GEOGRAPHICALLY RECTIFIED TO THE UNIVERSAL TRANSVERSE MERCATOR (UTM) COORDINATE SYSTEM USING U.S. GEOLOGICAL SURVEY (USGS) 1:24,000 SCALE 7.5 MINUTE TOPOGRAPHIC QUADRANGLES.



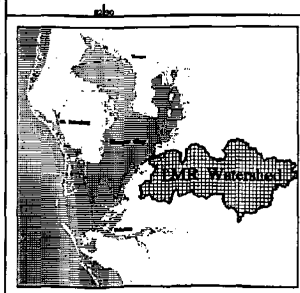
SPOT Satellite Basemap of the Little Manatee River Watershed

FLORIDA DEPARTMENT OF NATURAL RESOURCES

Florida Department of Natural Resources
Division of Marine Resources
Florida Marine Research Institute
Marine Resources Geographic Information System



THIS OVERLAY SHOWS THE SUBBASINS OF THE LITTLE MANATEE RIVER WATERSHED AS DEFINED BY THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT (SWFWMD).



Subbasins of the Little Manatee River Watershed

1. LMR - Below SR-301
2. Sun City Slough
3. Wildcat Creek
4. Unnamed Drainage Ditch
5. Ruskin Inlet Marsh Branch
6. Mills Bayou
7. Hayes Bayou
8. Bolster Bayou
9. Curiosity Creek
10. Cypress Creek
11. Below Cypress Gage
12. Unnamed Slough
13. Dug Creek
14. Below Dug Gage
15. LMR - Wimauma
16. Lake Wimauma
17. Lake Wimauma Drain
18. Below South Gage
19. Gully Branch
20. Carlton Branch
21. Below Carlton Gage
22. LMR - North Fork
23. Unnamed Stream
24. Moody Branch
25. Baker branch
26. LMR - South Fork
27. Keen Branch
28. Pierce Branch
29. Unnamed Drain
30. LMR - Lonesome
31. Upper Howard Prairie Branch
32. Lower Howard Prairie Branch
33. Long Branch
34. Mined Area
35. Alderman Creek
36. Mined Area

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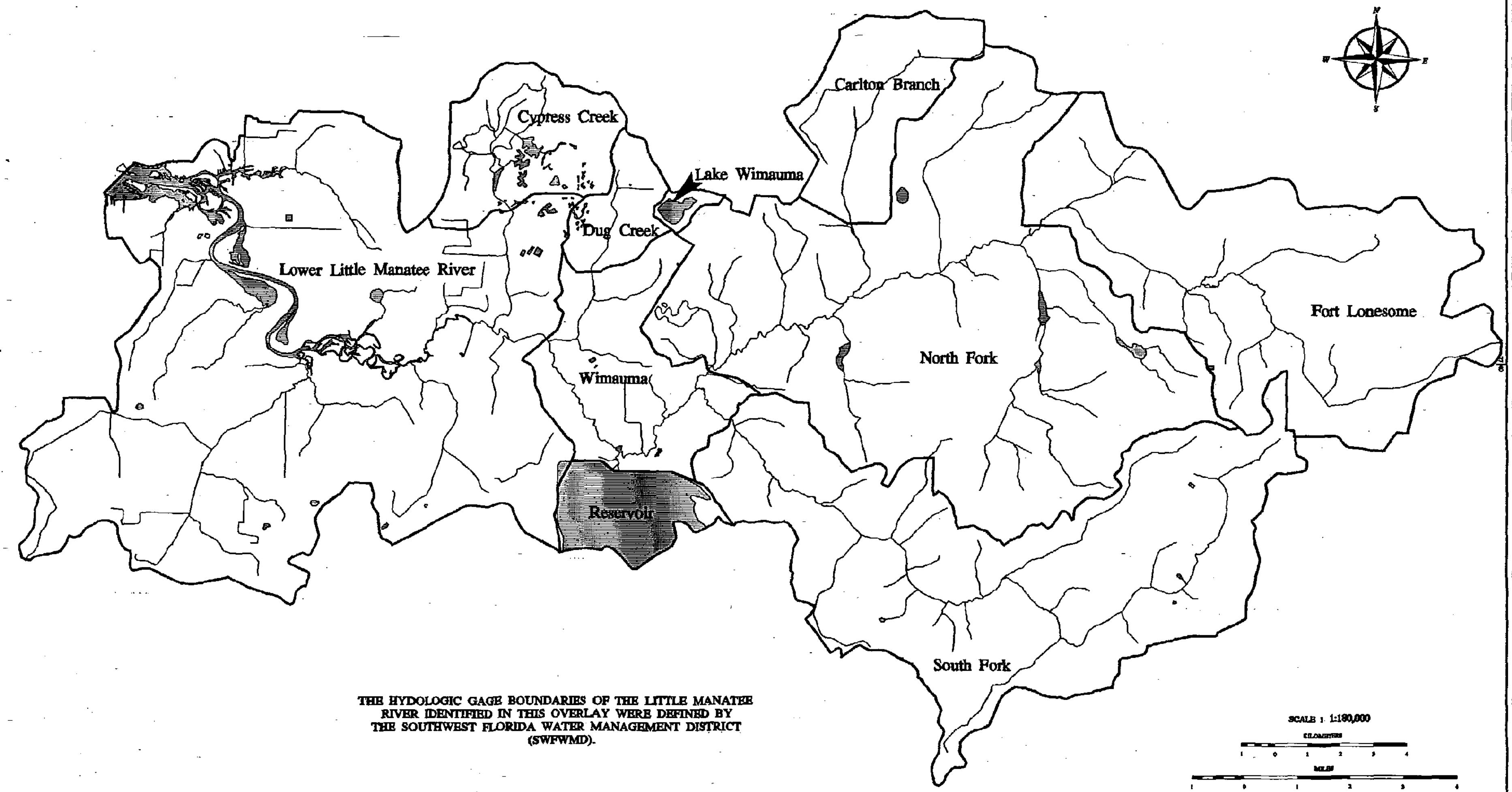
Drainage and Hydrologic Gage Boundaries



THE HYDROLOGIC GAGE BOUNDARIES OF THE LITTLE MANATEE RIVER IDENTIFIED IN THIS OVERLAY WERE DEFINED BY THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT (SWFWMD).

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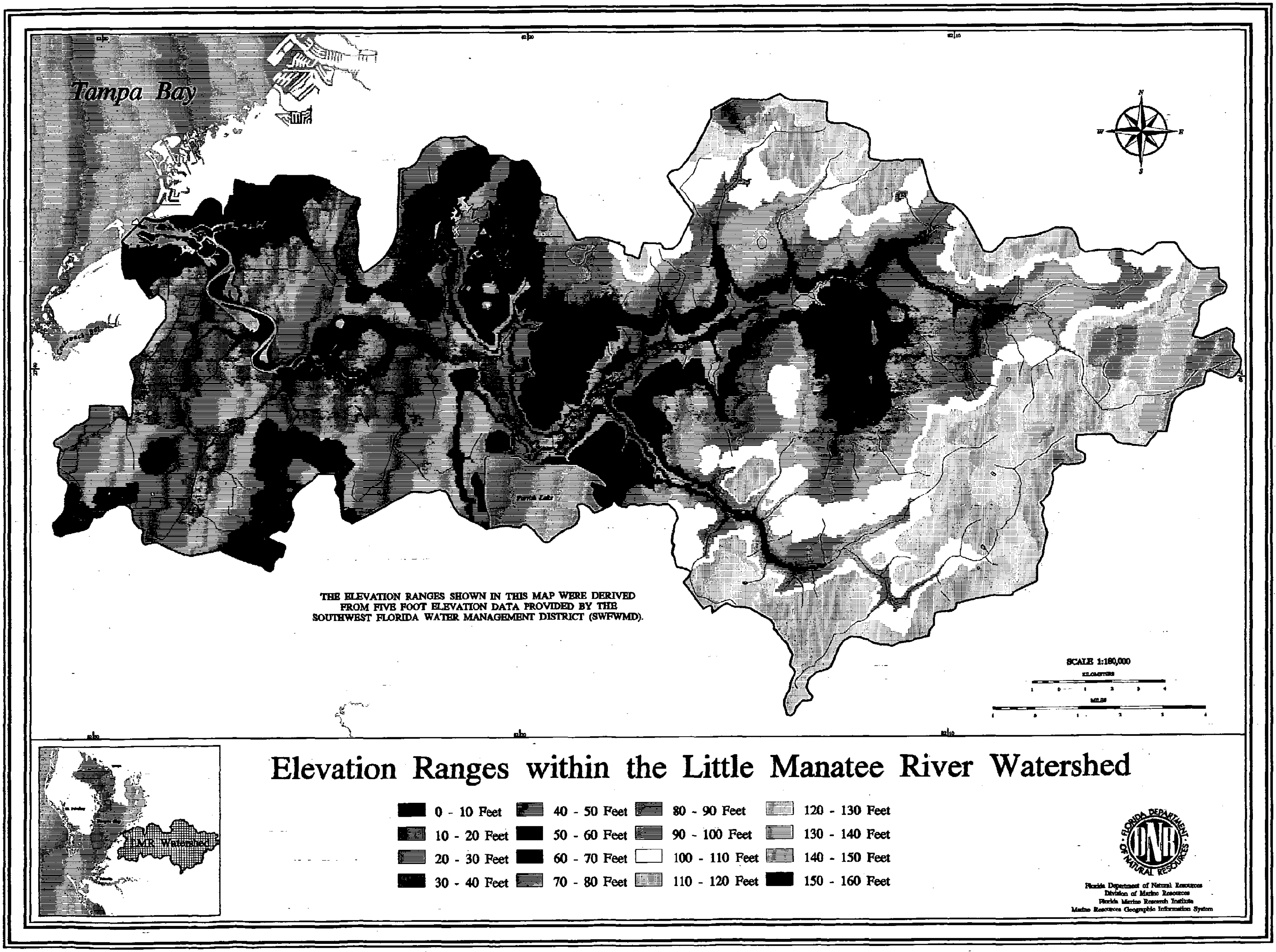
Tampa Bay
Elevation Ranges within the Little Manatee River Watershed
0 - 10 Feet
10 - 20 Feet
20 - 30 Feet
30 - 40 Feet
40 - 50 Feet
50 - 60 Feet
60 - 70 Feet
70 - 80 Feet
80 - 90 Feet
90 - 100 Feet
100 - 110 Feet
110 - 120 Feet
120 - 130 Feet
130 - 140 Feet
140 - 150 Feet
150 - 160 Feet
THE ELEVATION RANGES SHOWN IN THIS MAP WERE DERIVED FROM FIVE FOOT ELEVATION DATA PROVIDED BY THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT (SWFWMD).
SCALE 1:180,000
KILOMETERS
MILES
N
S
E
W
LMR Watershed
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DNR
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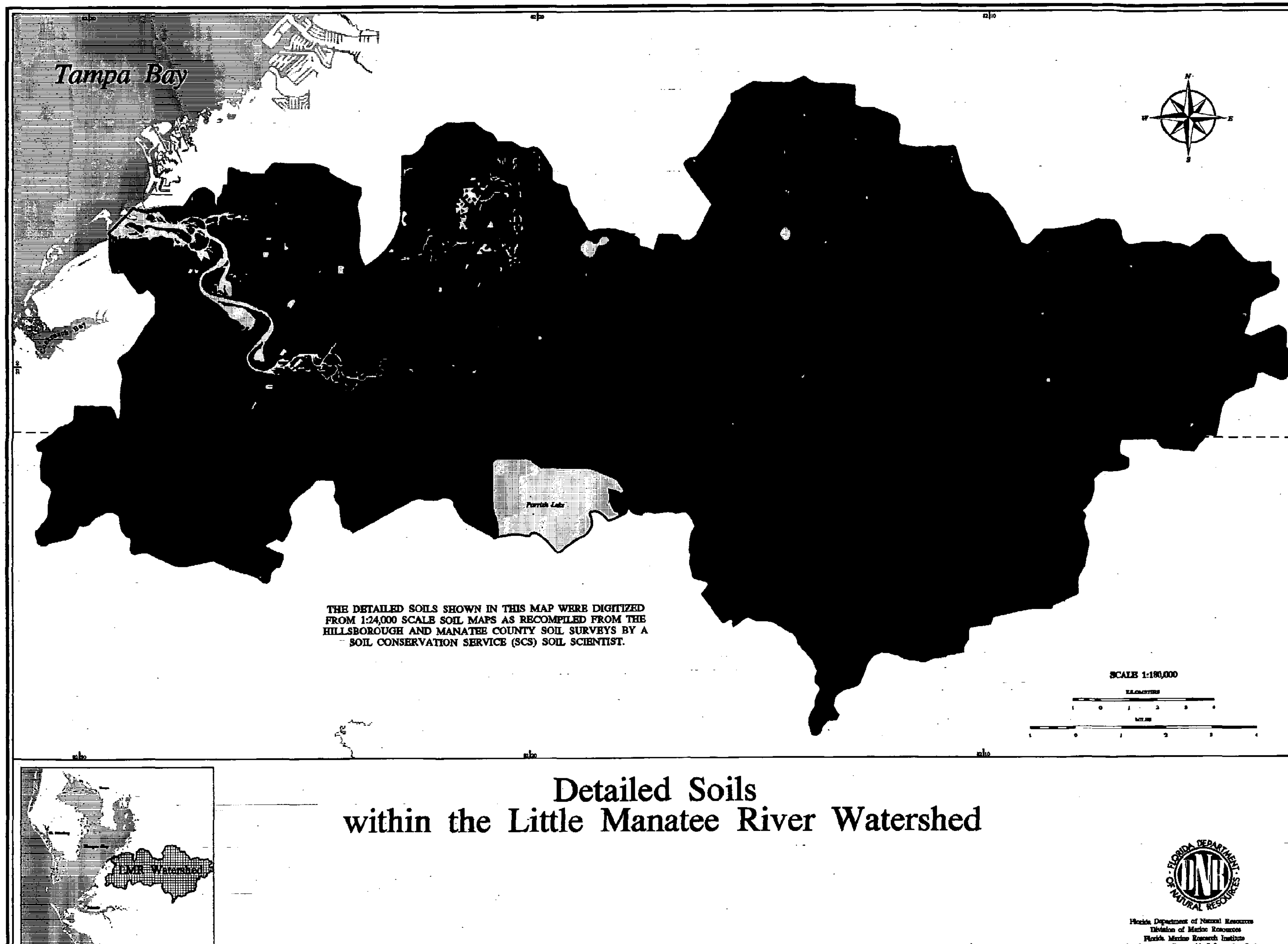
Division of Marine Resources
Florida Marine Research Institute
Marine Resources Geographic Information System



Detailed Soils within the Little Manatee River Watershed

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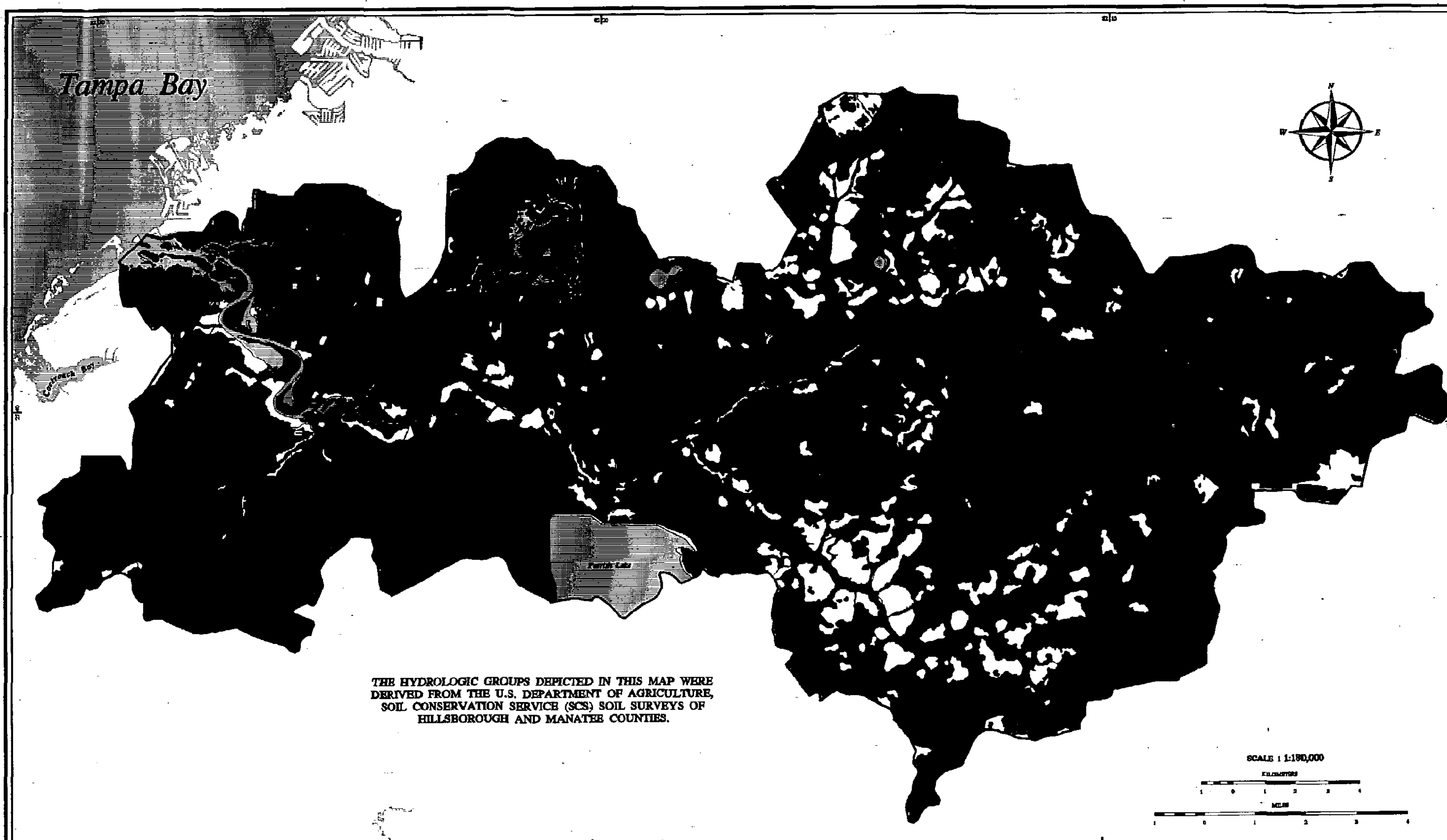

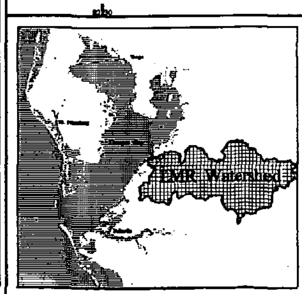

Soil Hydrologic Groups within the Little Manatee River Watershed

- Hydrologic Group D = High Runoff Potential/Very Slow Infiltration Rate
- Hydrologic Group B/D = Combination of Hydrologic Groups B and D
- Hydrologic Group C = Slow Infiltration Rate
- Hydrologic Group B = Moderate Infiltration Rate
- Hydrologic Group A = Low Runoff Potential/High Infiltration Rate
- Undefined Runoff Potential
- Land Outside the Watershed
- Open Water

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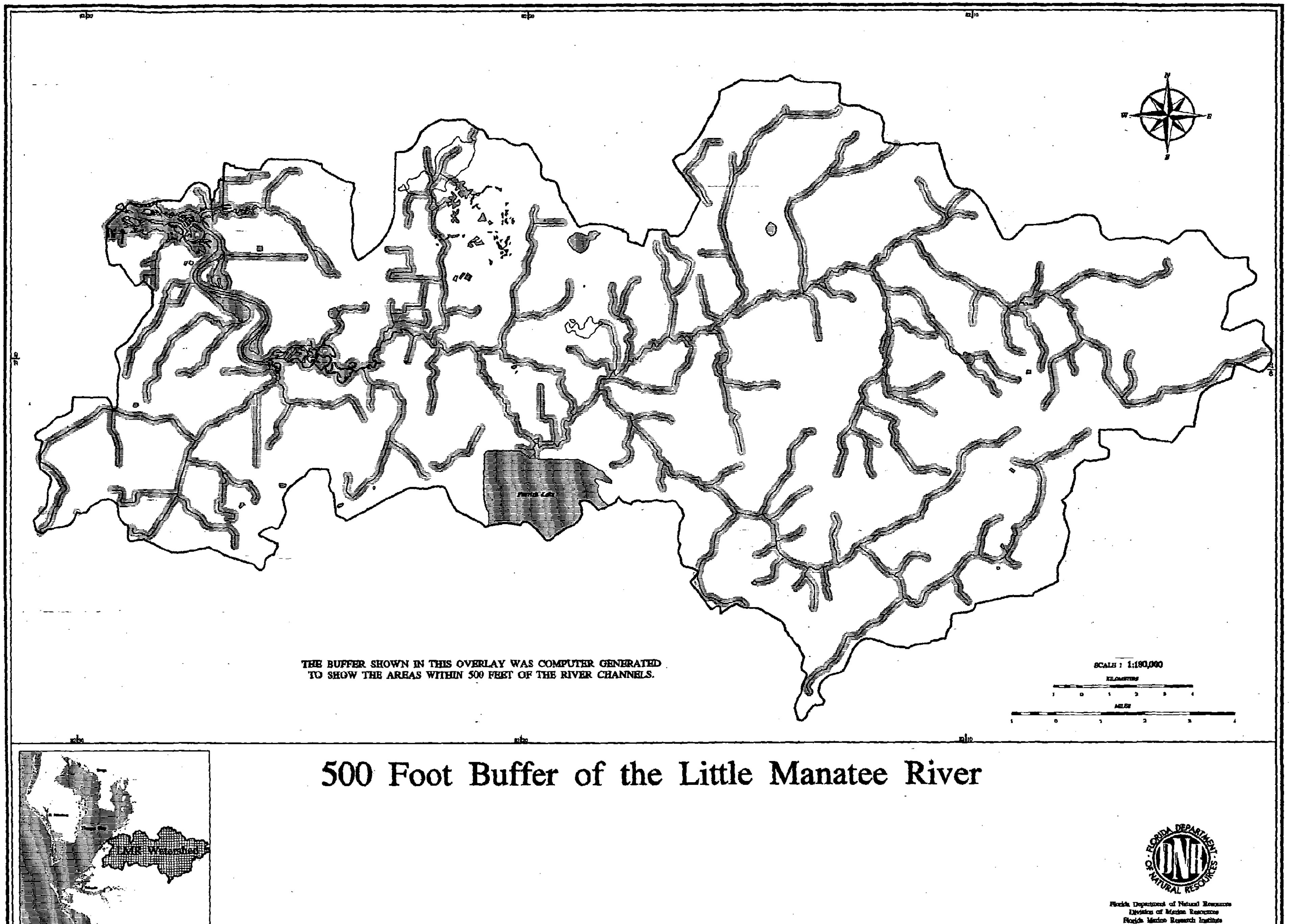

500 Foot Buffer of the Little Manatee River

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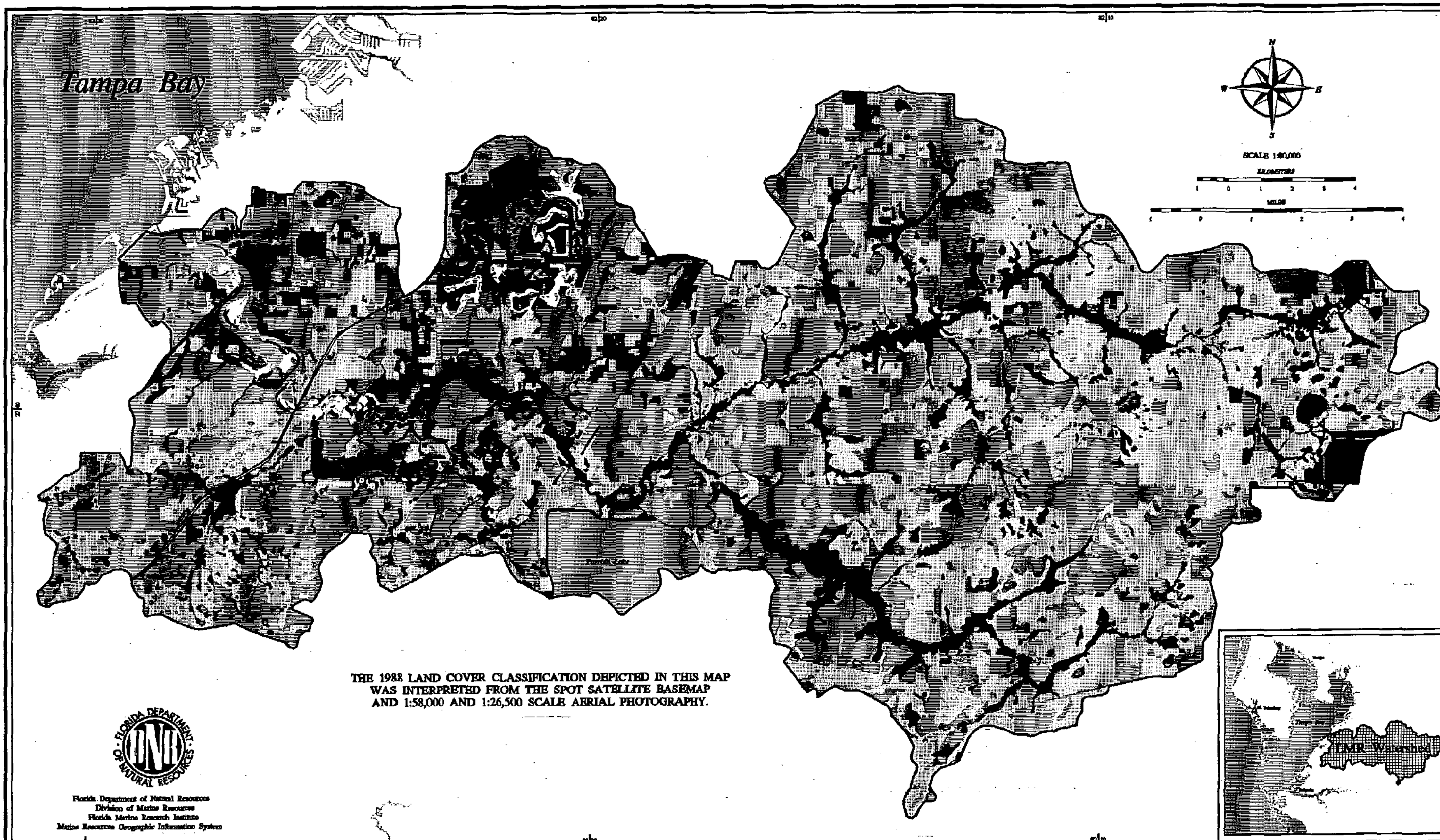
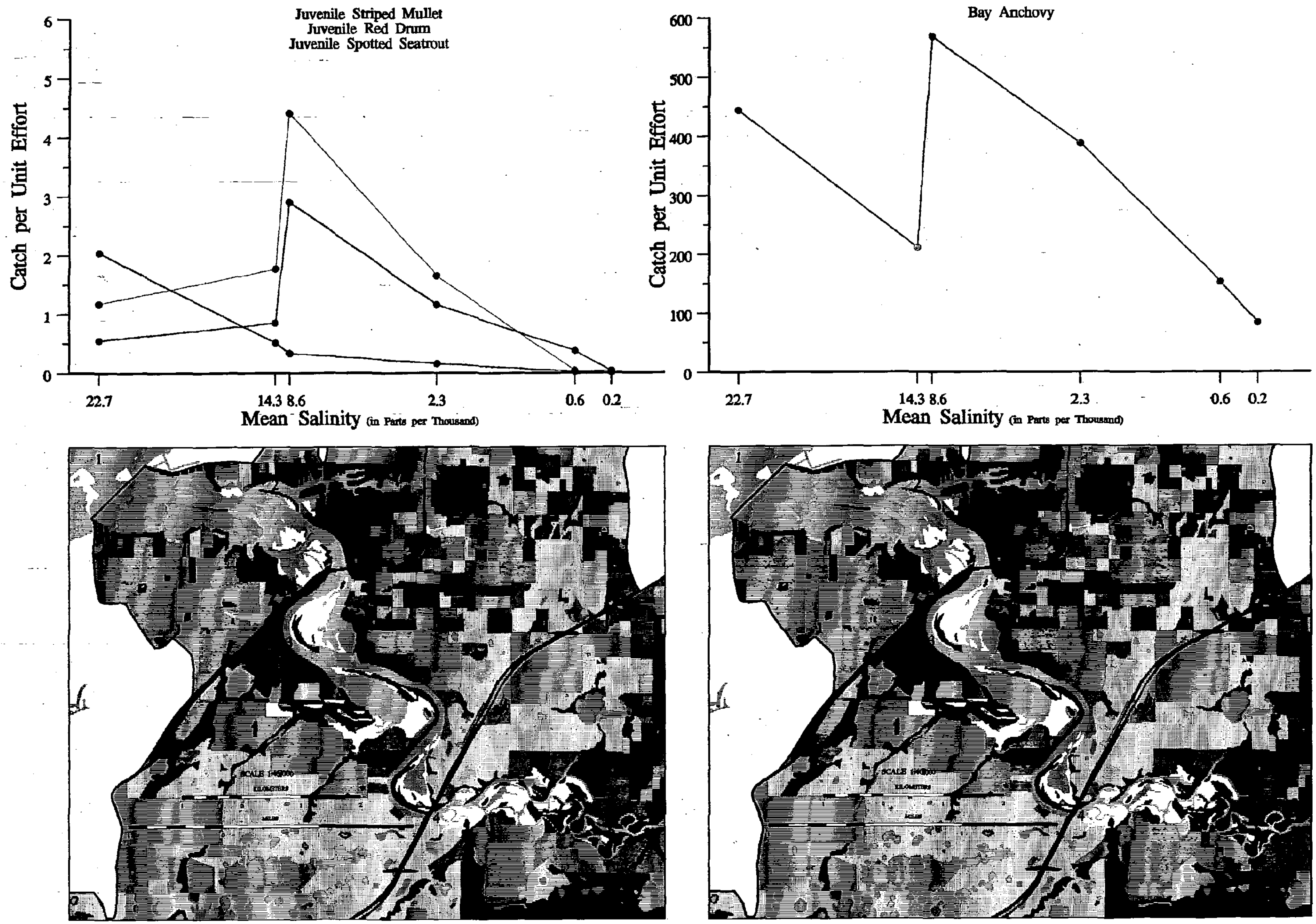


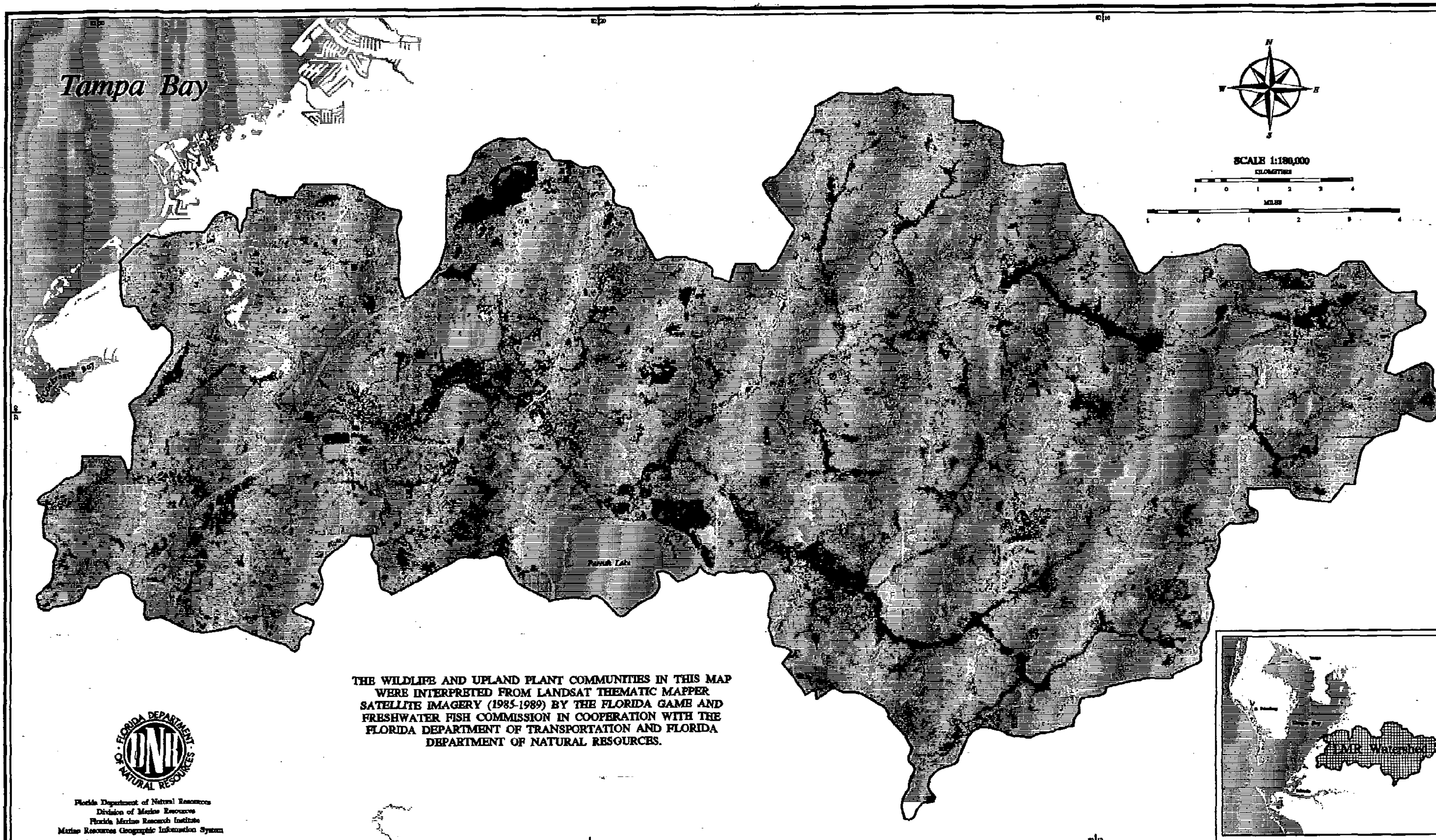
Little Manatee River Watershed - Land Cover 1988

Land Outside the Watershed		Forested Wetlands	17,952*	Hardwood Forest	3,377*	Commercial	542*
Open Water (inside the Watershed only)	5,229*	Citrus	12,499*	Rangeland, Shrub & Brush	12,424*	Mining	1,236*
Mangroves	267*	Row Crop	26,295*	Forested Pine Flats	9,360*	Golf Course	785*
Saltmarsh	597*	Fish Farm	816*	Suburban	7,247*	Airstrip	56*
Herbaceous Wetlands	5,632*	Pasture	37,377*	Utility	151*	Transportation	558*

*Area Calculations Measured in Acres



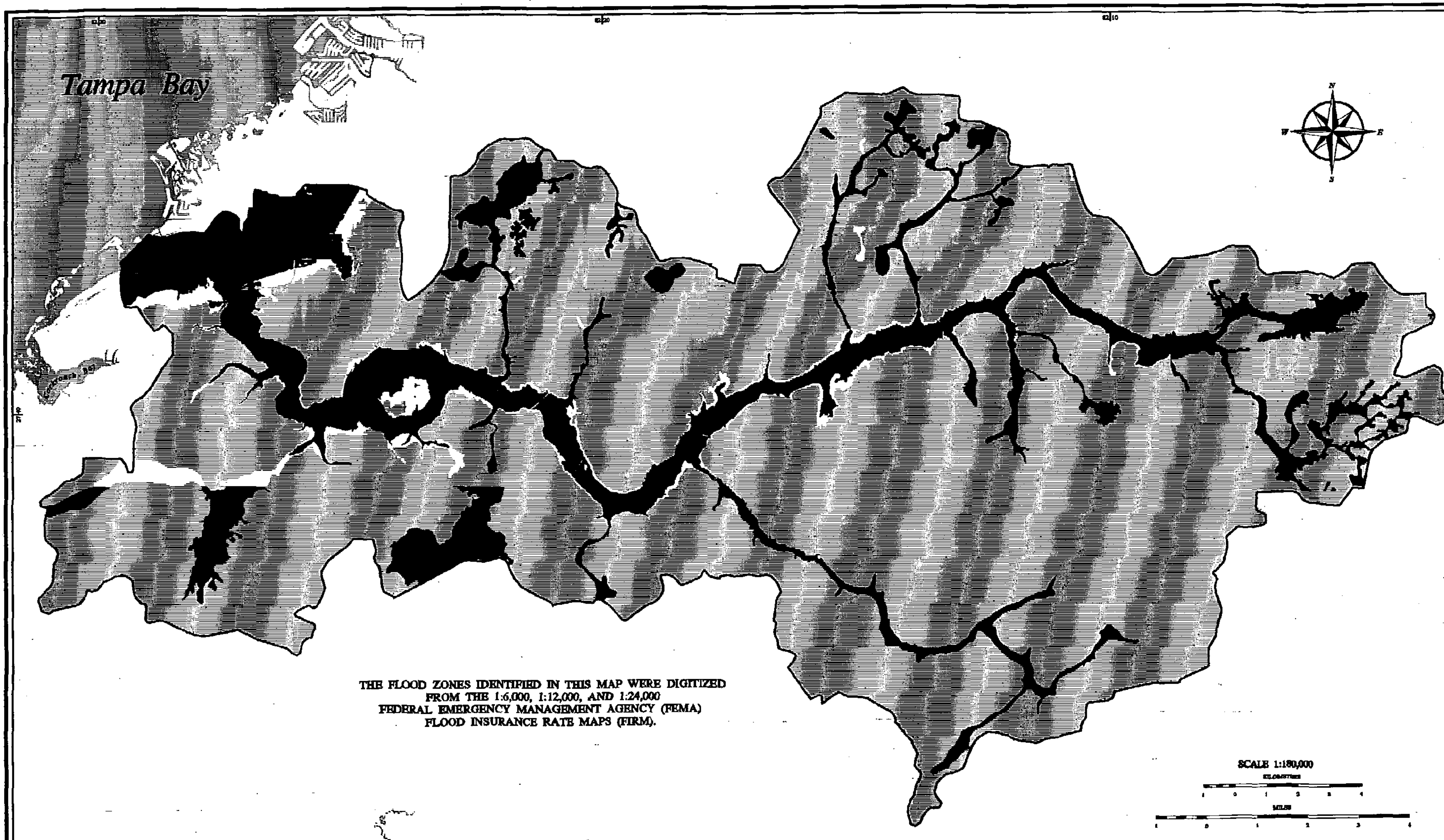
THIS FIGURE DEPICTS THE RELATIONSHIP AMONG SALINITY, SAMPLING STATION, AND CATCH PER UNIT EFFORT FOR SELECTED SPECIES OF FISH IN THE ESTUARINE PORTION OF THE LITTLE MANATEE RIVER. CATCH VALUES ARE BASED UPON A BIWEEKLY SAMPLING STRATEGY WHICH UTILIZED SEINES AND TRAWLS FROM JANUARY 1988 THROUGH DECEMBER 1991. SAMPLING STATIONS ARE SHOWN ON THE BASIS OF THE 1988 LAND COVER LAYER.



Wildlife And Upland Plant Communities

Land Outside the Watershed		Sand Pine Scrub	600*	Saltmarsh	549*	Mangroves	289*
Open Water (inside the Watershed only)	4,151*	Sandhill	84*	Freshwater Wetland	5,184*	Grassland	55,294*
Uninterpreted Area	64*	Xeric Oak Scrub	571*	Cypress Swamp	793*	Shrub and Brushland	16,479*
Dry Prairie	7,697*	Mixed Hardwood/Pine Forest	4,878*	Hardwood Swamp	6,286*	Barren Land	27,356*
Pinelands	2,515*	Hardwood Hammock & Forest	9,479*	Shrub Swamp	96*		

*Area Calculations Measured in Acres



Little Manatee River Watershed - Flood Zones

V Zone - Area of 100 Year Flood with Velocity	240*	Open Water
A Zone - Area of 100 Year Flood	22,224*	Land Outside the Watershed
B Zone - Area Between 100 Year & 500 Year Flood	4,018*	
C Zone - Area of Minimal Flooding	115,887*	

*Area Calculations Measured in Acres

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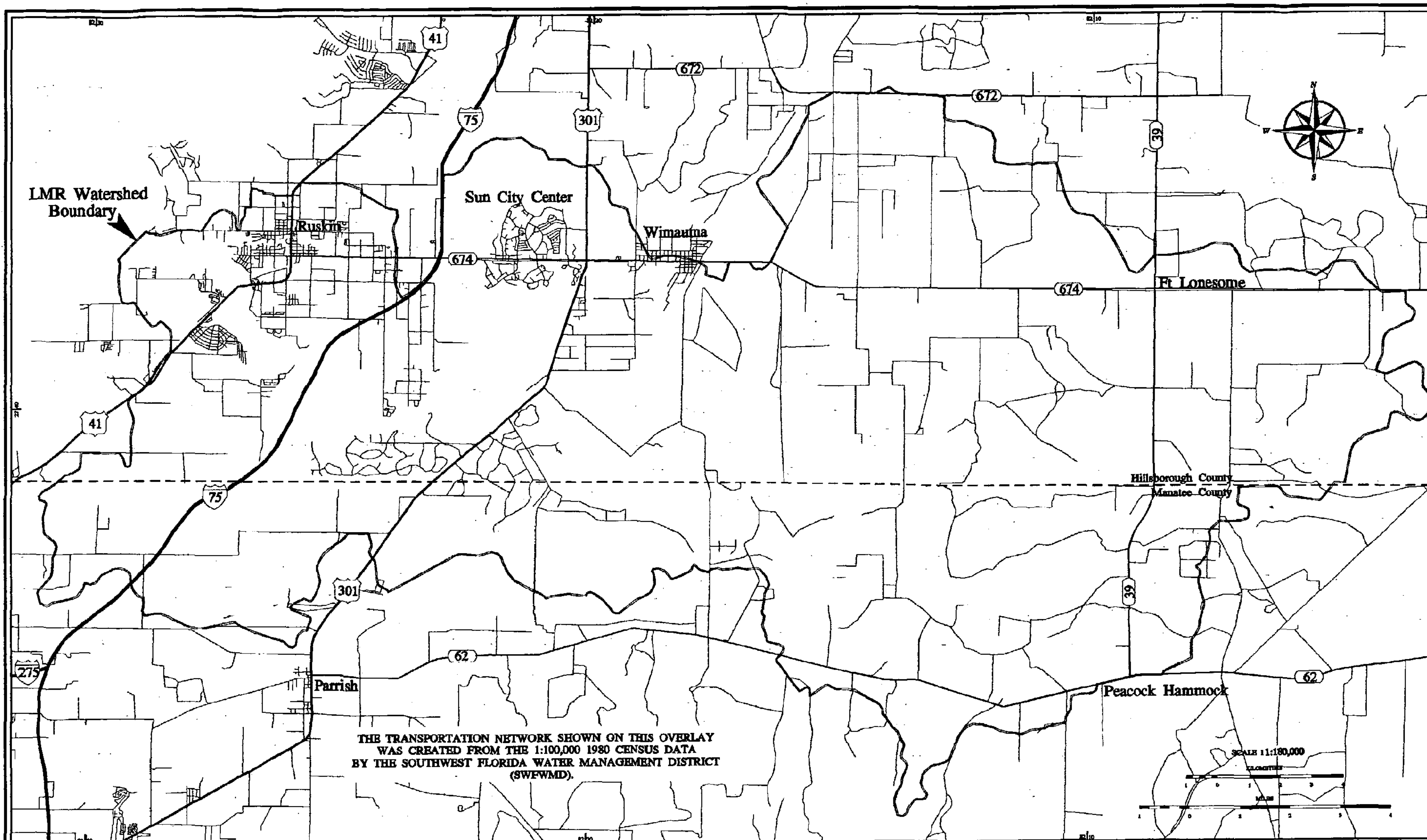
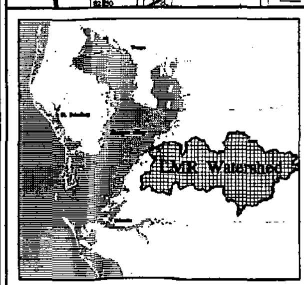


Transportation Network



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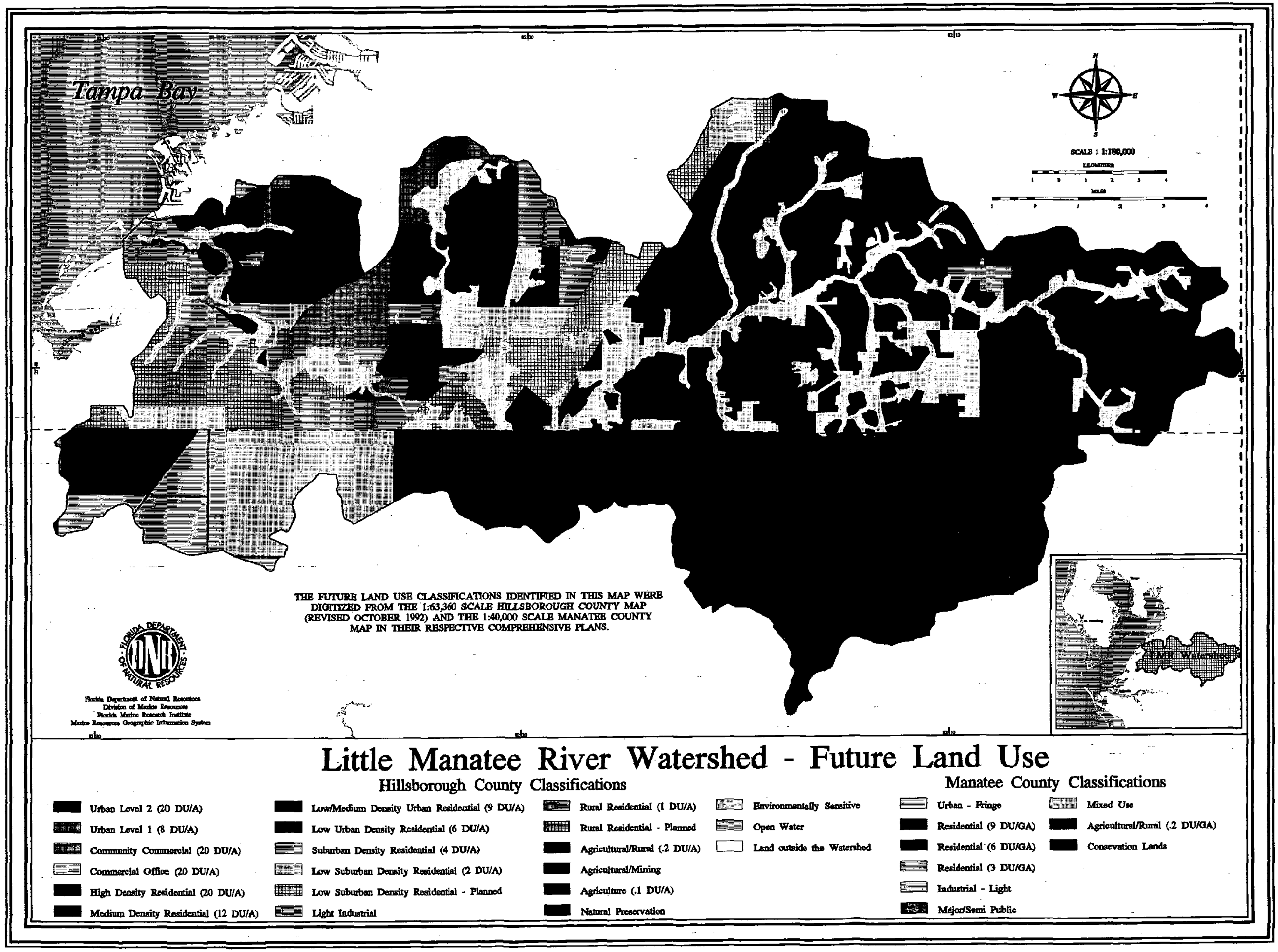

Tampa Bay
SCALE 1 1:180,000
KILOMETERS
MILES
N
S
E
W
THE FUTURE LAND USE CLASSIFICATIONS IDENTIFIED IN THIS MAP WERE DIGITIZED FROM THE 1:63,360 SCALE HILLSBOROUGH COUNTY MAP (REVISED OCTOBER 1992) AND THE 1:40,000 SCALE MANATEE COUNTY MAP IN THEIR RESPECTIVE COMPREHENSIVE PLANS.
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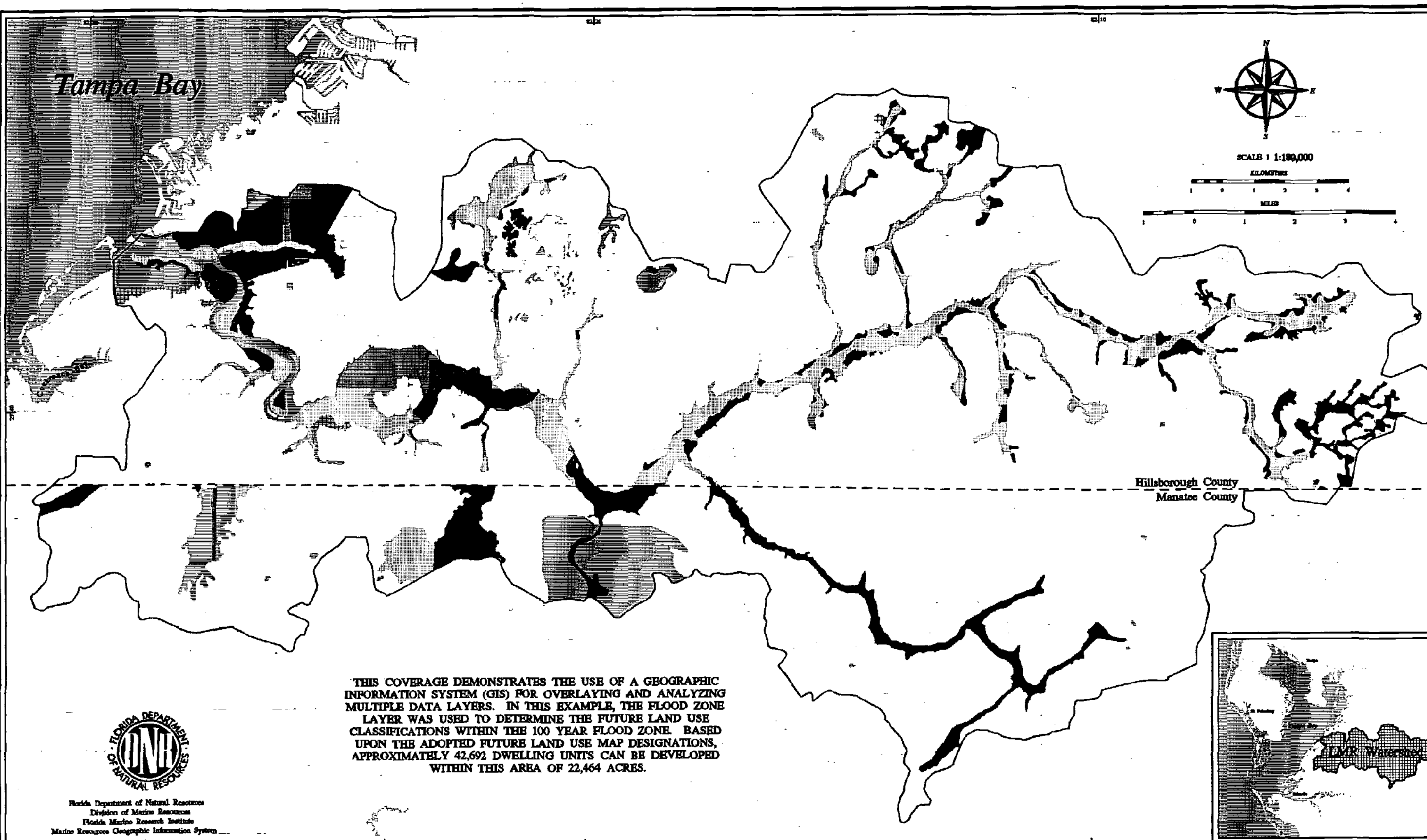
Division of Marine Resources
Florida Marine Research Institute
Marine Resources Geographic Information System
LMR Watershed
Little Manatee River Watershed - Future Land Use
Hillsborough County Classifications
Urban Level 2 (20 DU/A)
Urban Level 1 (8 DU/A)
Community Commercial (20 DU/A)
Commercial Office (20 DU/A)
High Density Residential (20 DU/A)
Medium Density Residential (12 DU/A)
Low/Medium Density Urban Residential (9 DU/A)
Low Urban Density Residential (6 DU/A)
Suburban Density Residential (4 DU/A)
Low Suburban Density Residential (2 DU/A)
Low Suburban Density Residential - Planned
Light Industrial
Rural Residential (1 DU/A)
Rural Residential - Planned
Agricultural/Rural (.2 DU/A)
Agricultural/Mining
Agriculture (.1 DU/A)
Natural Preservation
Environmentally Sensitive
Open Water
Land outside the Watershed
Manatee County Classifications
Urban - Fringe
Residential (9 DU/GA)
Residential (6 DU/GA)
Residential (3 DU/GA)
Industrial - Light
Major/Semi Public
Mixed Use
Agricultural/Rural (.2 DU/GA)
Conservation Lands



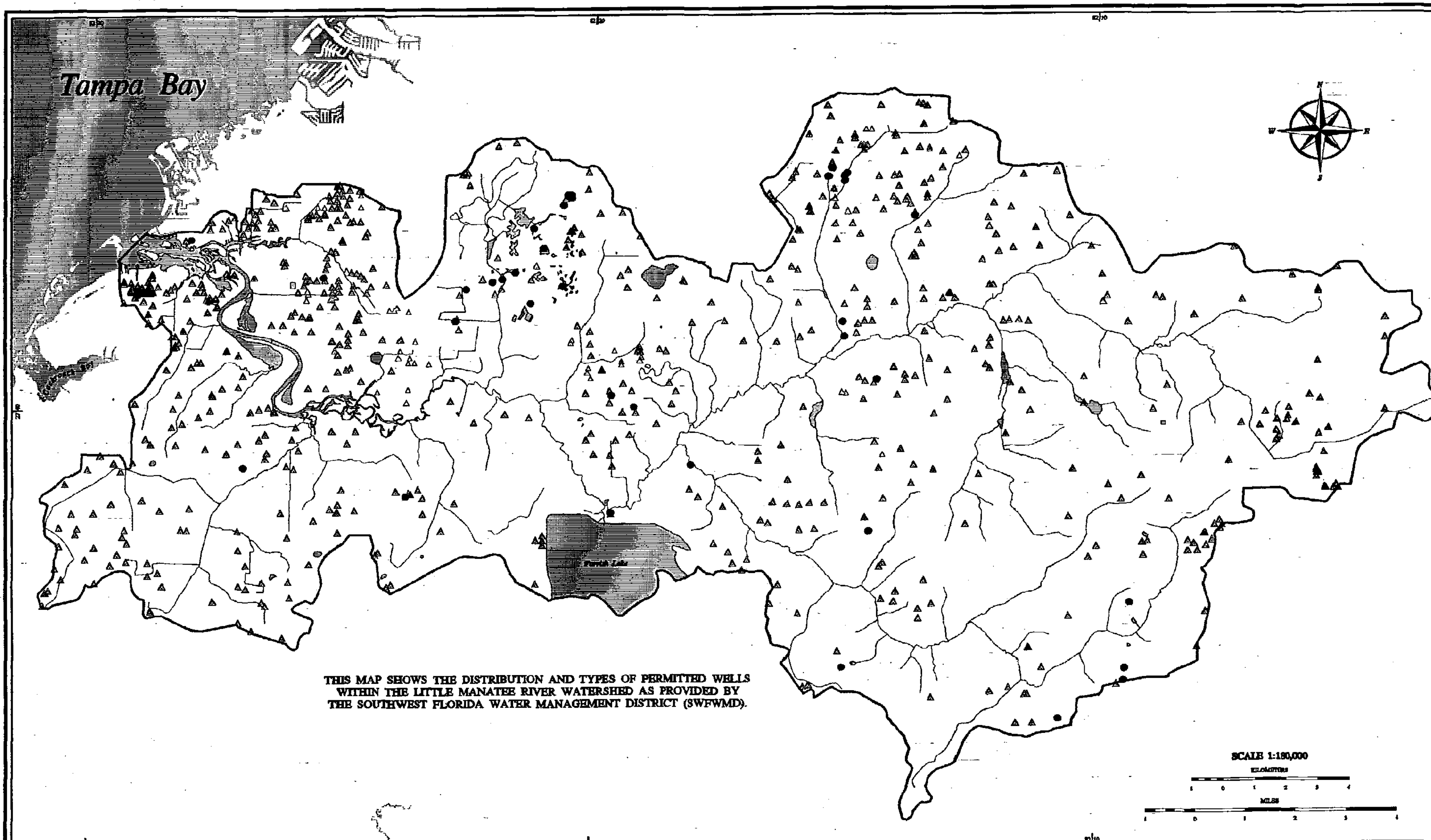
Future Land Use Classifications within the 100 Year Flood Zone

Hillsborough County Classifications

- Urban Level 2 (20 DU/A)
- Urban Level 1 (8 DU/A)
- Community Commercial (20 DU/A)
- Commercial Office (20 DU/A)
- High Density Residential (20 DU/A)
- Medium Density Residential (12 DU/A)
- Low/Medium Density Urban Residential (9 DU/A)
- Low Urban Density Residential (6 DU/A)
- Suburban Density Residential (4 DU/A)
- Low Suburban Density Residential (2 DU/A)
- Low Suburban Density Residential - Planned
- Light Industrial
- Rural Residential (1 DU/A)
- Rural Residential - Planned
- Agricultural/Rural (.2 DU/A)
- Agricultural/Mining
- Agriculture (.1 DU/A)
- Natural Preservation
- Environmentally Sensitive
- Open Water
- Land outside the Watershed

Manatee County Classifications

- Urban - Fringe
- Residential (9 DU/GA)
- Residential (6 DU/GA)
- Residential (3 DU/GA)
- Industrial - Light
- Major/Semi Public
- Mixed Use
- Agricultural/Rural (.2 DU/GA)
- Conservation Lands



Locations and Types of Permitted Wells

Surface Wells		Ground Wells
Tropical Fish Farm	Recreational Facility	Industrial/Mining
Dairy Farming	Agricultural Use	Agricultural Use
Residential Use	Industrial/Mining	Recreational Use
Sewage Treatment		Undefined Usage

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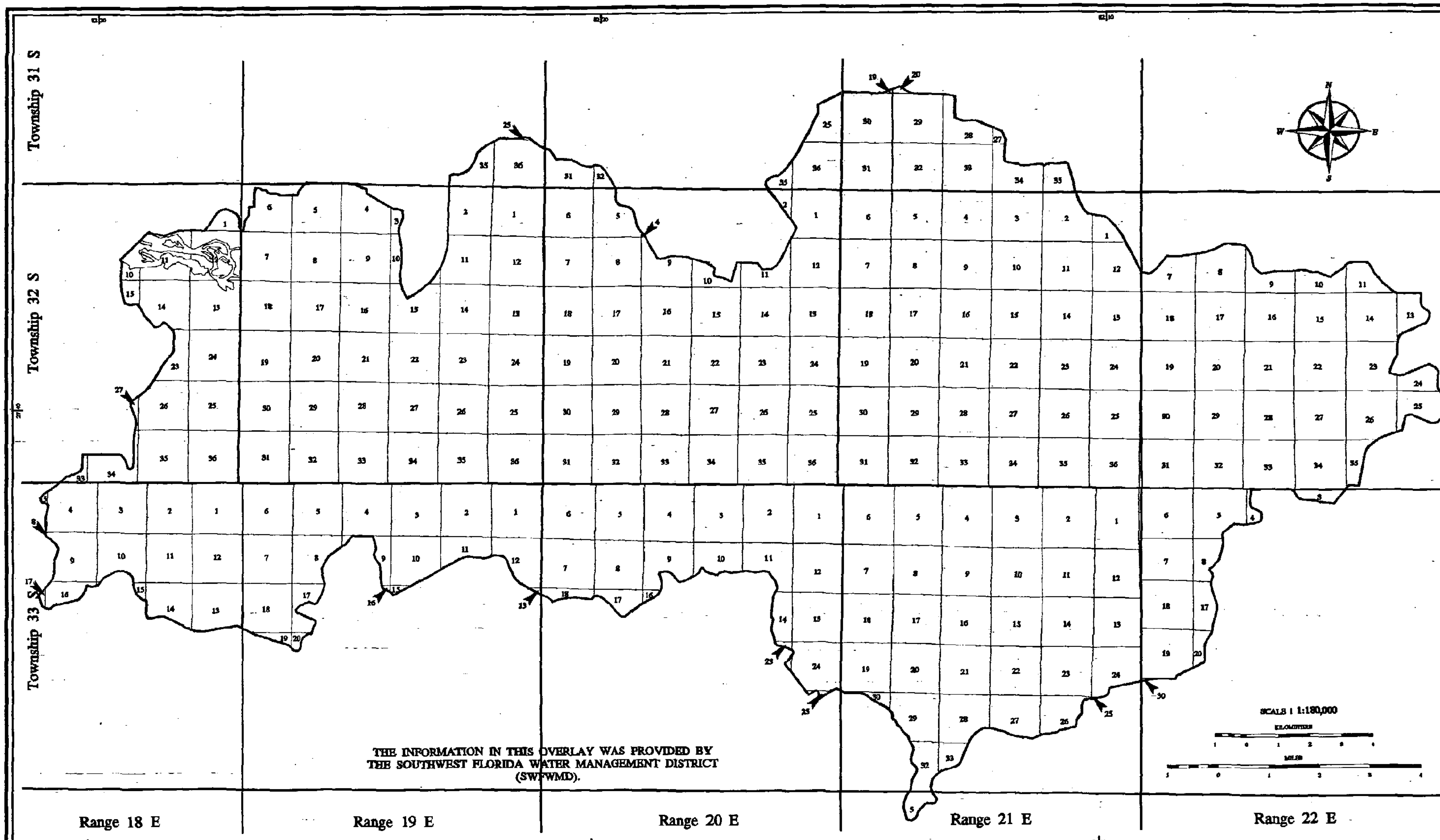

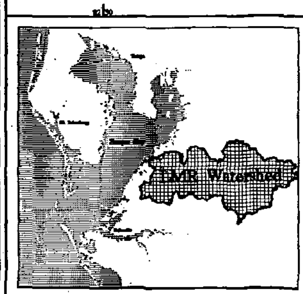

Section-Township-Range Grid within the Little Manatee River Watershed

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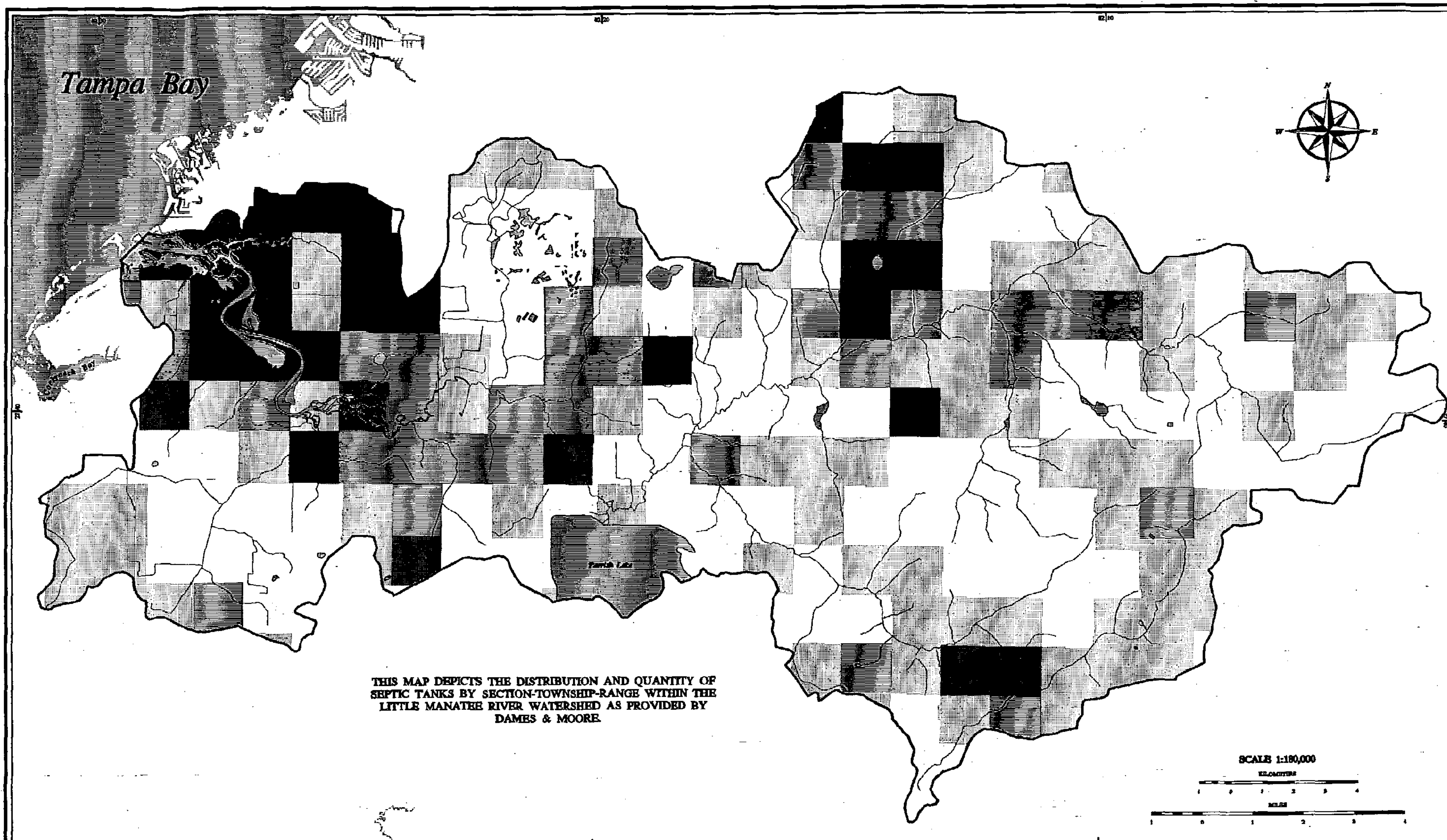

Density of Septic Tanks

- Sections with No Septic Tanks
- Sections with 1-5 Septic Tanks
- Sections with 6-10 Septic Tanks
- Sections with 11-15 Septic Tanks
- Sections with 16-20 Septic Tanks
- Sections with 21-25 Septic Tanks
- Sections with 26-30 Septic Tanks
- Sections with 35-40 Septic Tanks
- Sections with 50-100 Septic Tanks
- Sections with 101-150 Septic Tanks
- Sections with 151-200 Septic Tanks
- Sections with 201-300 Septic Tanks
- Sections with 301-400 Septic Tanks
- Sections with More than 500 Septic Tanks
- Open Water
- Land Outside the Watershed

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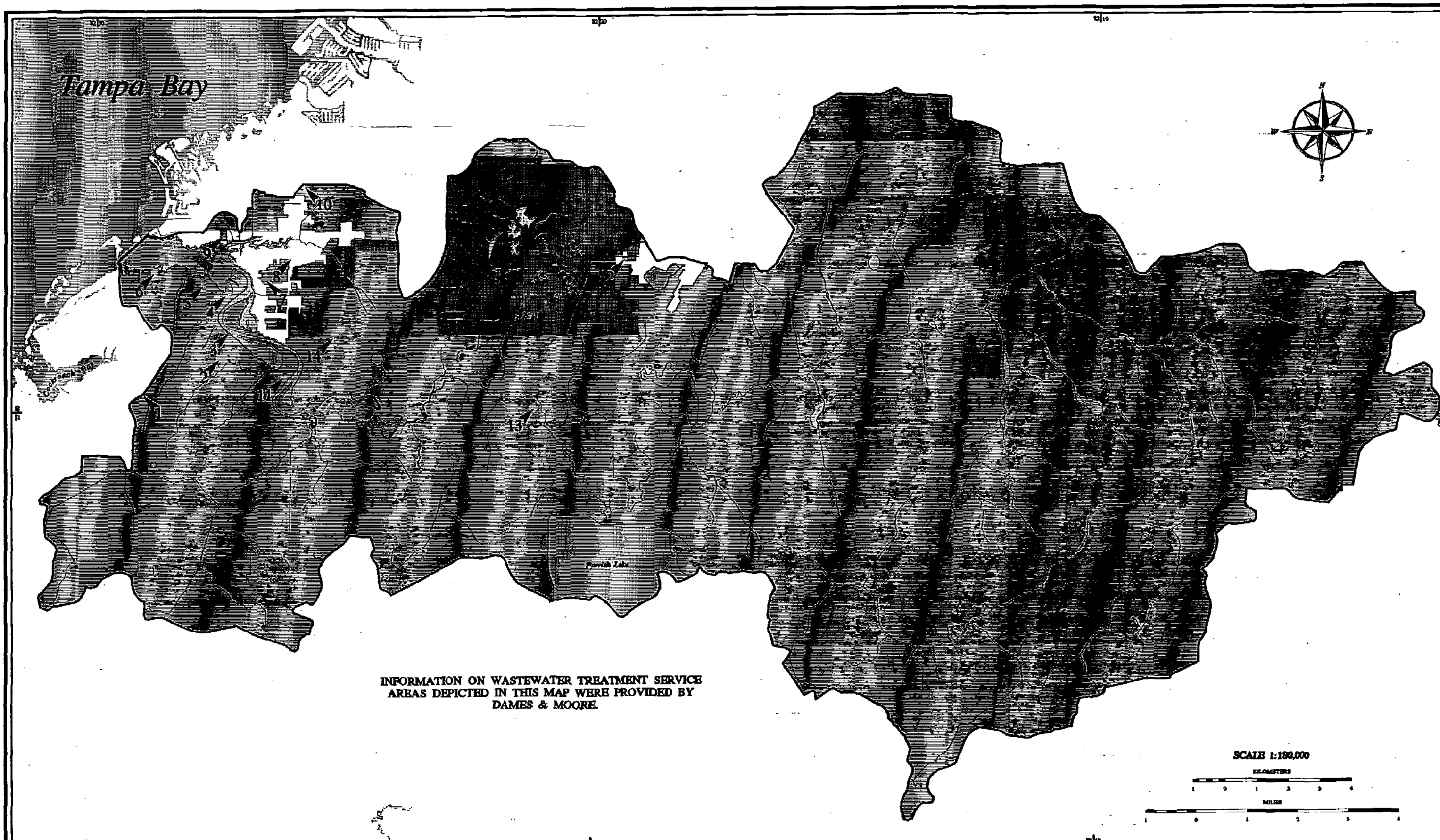

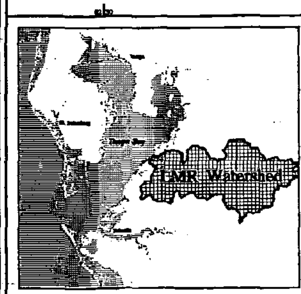

Wastewater Treatment Service Areas

- Area Serviced By County Wastewater System
- Mixed–Septic Tanks And County Wastewater System
- Industrial Wastewater System
- Open Water
- Land Inside the Watershed Not Presently Serviced
- Approximate Area Serviced By Interim Wastewater Treatment Plants

1. Manatee R.V.P.	35.0*	8. Riverwood Apartments	15.0*
2. Strawberry Ridge	150.0*	9. Riverhaven M.H.P.	9.0*
3. Hide-A-Way Campground	30.0*	10. Holiday Palms R.V.P.	10.0*
4. Chula Vista M.H. S/D	25.0*	11. Little Manatee Campground	10.0*
5. Neptune M.V.	26.5*	12. Sun City M.H.P.	8.3*
6. Little Manatee Isles	30.0*	13. Little Manatee River M.H.P.	40.0*
7. Woodland Estates M.H.P.	11.2*	14. Hills. Co. Rest Area	20.0*

*Flow Measured in Thousands of Gallons Per Day (TGD)

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APPENDIX B

Annotated Data Dictionary Template

A. Entity Template

An entity is an object in space, for example a bridge, that is represented as a point, line, or polygon on a map. The object is described by a set of attributes such as composition, length, number of lanes, etc.

1. Label

The reference name for the entity.

2. Entity Authority

The source of the definition. For example, the entity authority could be by the author, a professional organization, a dictionary, etc.

3. Definition

A definition of an object potentially consists of two components, a description of the object like one would find in a dictionary and the procedures that were used to measure it.

a. Description

A general description of the object, ie. a bridge is a foot path or road way that spans a water course or crevice.

b. Measurement/Determination

This describes how the object was measured. This may not be pertinent to all entities and is left to the discretion of the documenter. An example of an entity description that would require completion of this section would be the sources of an abstraction, ie. if group of polygons describing components of an estuary were collapsed into a larger polygon at a higher level of classification, it would be important to know what the subclasses consisted of.

4. Point, Line, Polygon

This is for information purposes to describe how the object is represented in space.

Point: A zero-dimensional object that specifies geometric location. One coordinated pair or triplet specifies the location.

Line: A direct line between two points. It should be inclusive of the term string which is: an ordered sequence of points representing a connected non-branching sequence of line segments.

Polygon: A set of non-intersecting lines, with closure, that represents a two dimensional object in space.

5. Quantity of Data

A description of how much data, in terms of computer storage, this object occupies. The units of measure must be provided.

B. Attribute Template

An attribute is a defined characteristic of an entity, for example, composition is a possible attribute for a bridge.

1. Label

The reference name of the attribute.

2. Attribute Authority

The source of the definition. For example, the entity authority could be by the author, a professional organization, a dictionary, etc. A complete reference should be provided where possible .

3. Definition

A definition of an attribute potentially consists of two components, a description of the object like one would find in a dictionary and the procedures that were used to measure it.

a. Description

A general description of the attribute, ie. one of the attributes of a bridge would be its composition, that is what it is made of.

b. Measurement/Determination

This describes how the attribute was measured, but it may not be pertinent to all entities and is left to the discretion of the documenter. An example of an attribute description that would be the laboratory procedures for measuring mercury. This could be quiet extensive and provisions have been made to allow an unlimited amount of space for documentation, this information may be imported from existing electronic documents. If there are aliases and the documenter feels that they are important, they should be included in this section.

4. Domain value

Describes the format that the attribute value can take. The set in which a variable is expressed, i.e., alpha, alphanumeric, graphic character, integer, etc.

a. Character type

There are six major specifications of type:

A data type indicates the manner in which the field or subfield will be encoded. This is relevant to the data transfer and not to a data dictionary.

A Graphics characters, alphanumeric characters, or alphabetic characters
I Implicit-point (integer)
R Explicit-point unscaled (real)
S Explicit-point scaled (real with exponent)
B Bitfield data (unsigned binary, per agreement)
C Character mode bitfield (binary in zero and one characters)

b. Allowable values (domain enumeration)

1. Length

This identifies the number of characters in the variable field.

2. Number of significant digits

The number of decimal places that are meaningful. For example, in dealing with dollars and cents there are two significant digits. If you have a value such as $1.53 multiplied by .18, you will have an answer of .1754, but the answer will only be valid (and sensible) to the second decimal. Thus the correct answer, rounding to the nearest 100th, is .18.

3. Units of measure

Identifies what measurement was used for a value, i.e. dollars, francs, feet, inches, meters, pounds, kilograms, etc.

c. Categorical

Data elements which only take up certain values, i.e., a department number which can take on the values 06, 20 and 33, but no other values.

1. Value

The actual categories, such as Fl, Ga, Al.

2. Meaning

Definition of the values i.e., Fl = Florida, Ga = Georgia, Al = Alabama.

d. Continuous

Data elements, which for all practical purposes, can take any value within a range, i.e., a dollar amount from zero to $999,999,999.99 to the nearest cent.

1. Range of values

The range of values is the minimum and maximum value.

a. Minimum

1. value

Minimum numerical value.

2. inclusive/exclusive

This defines whether or not the minimum numerical value included in the range or is it excluded in the range. An example of an excluded minimum would be a range of numbers from 5.000 to 10.000 where the least value would be 5.001 but never 5.000. If the number was inclusive the minimum value would be 5.000.

b. Maximum

1. value

Maximum numerical value.

2. inclusive/exclusive

Conceptually the same as minimum inclusive/exclusive, but the maximum value.

2. Typical value

Give some indication as to what a typical value would be. This may be described as a mean, median or mode, if appropriate. It is not necessary to calculate these values. The purpose is to provide a "general understanding of what is to be expected." Textual description is also appropriate with support for the derived number.

5. Other editing information

This would include programmatic edits from the source of data entry. Examples of edits would be upper or lower case, values = A through G, values less than 0, etc.

If editing features such as date fields, dollar marks, etc. are included with the data, this information should be included here.

Sample Data Dictionary Report:

Soils Data Set

A. Entity and its associated attributes

1. Label — Standard Soils Data Set
2. Entity Authority — Soil Conservation Service
3. Definition of the Entity — All attributes associated with each soil.
4. Point\Line\Polygon — Polygon
5. Quantity of Data — Unknown

B. Attribute Template

1. Label — ANFLOOD
2. Attribute authority — Soil Conservation Service
3. Definition
   a. Description — Annual Flooding Frequency. Descriptive term used to describe the probability that flooding will occur during any year.
   b. Measurement — Estimate based on the synthesis of evidence including, but not limited to: seasonal climatic data, river and coastal hydrological data, and field observations.
4. Domain Value
   a. Value Format
      1. Domain
         a. Character type — A (character)
         b. Allowable values (domain enumeration)
         1. Length — 5
         2. Number of significant digits — N/A
         3. Units of Measure — N/A

   b.1 Categorical
      1. Value — None
      2. Meaning — No reasonable possibility of flooding (near 0 percent chance of flooding in any year).

   b.2 Categorical
      1. Value — Rare
      2. Meaning — Flooding unlikely but possible under unusual weather conditions (from near 0 to 5 percent chance of flooding

in any year, or near 0 to 5 times in 100 years)

b.3 Categorical

1. Value — Occas

2. Meaning — Occasional. Flooding is expected infrequently under usual weather conditions. (5 to 50 percent chance of flooding in any year, or 5 to 50 times in 100 years.)

b.4 Categorical

1. Value — Freq

2. Meaning — Frequent. Flooding is likely to occur often under usual weather conditions (more than a 50 percent chance of flooding in any year, or more than 50 times in 100 years).

b.5 Categorical

1. Value — Comm

2. Meaning — Common. Occasional and frequent classes can be grouped for certain purposes and called COMMON flooding.

c. Continuous

1. Range of values

a. Minimum

1. value N/A

2. inclusive/exclusive N/A

b. Maximum

1. value N/A

2. inclusive/exclusive N/A

2. Typical value N/A

5. Other editing information — The category COMMON does not occur as often. It is found primarily in the older soil surveys.

QUALITY AND ACCURACY REPORT:

Template - Vector Data

Data Coverage Name: Enter a name for this thematic layer, i.e., LULC for Land Use Land Cover.

Data Coverage Description: Description of this coverage, its particulars, parameters, etc.

Organization: Name of organization that prepared/conducted this report.

Prepared By: Name of person who prepared report.

Section: Section of organization that prepared this report.

Department: Department that prepared this report.

Updated: Enter the update period for this report.

A. Lineage

1. Description of source material(s)

   a. **Lineage Name:** Brief, descriptive name of lineage, i.e., USGS 7.5 minute quads.

   b. **Scale:** Specify ratio, i.e., 1:24,000. Ratio between the distance on a map, chart, photograph or image and the corresponding distance on the surface of the Earth..

   c. **Datum:** Identify datum. Geodetic datum: ratio between the distance on a map, chart, photograph or image and the corresponding distance on the surface of the Earth.

   d. **Map Projection:** Systematic drawing of lines of a plane surface to represent the parallels of latitude and the meridians of longitude of the Earth, such as:

      polyconic
      UTM
      Lambert
      Transverse Mercator
      Albers
      Equidistance Cylindrical
      Miller Oblated Stereographic
      Stereographic
      Regulator Mercator
      Modified Transverse Mercator
      Bipolar Oblique Conic Conformal
      Other (name and explain)

   e. **Media of Source:** Origins of data and physical substance, i.e., color mylar, paper, etc.

   f. **Condition of Media:** Qualitative statement of condition of media, i.e., Excellent, Fair or Poor.

   g. **Creator organization/individual:** Name, address and phone number.

   h. **Date of Source Material:** History of development of source material; may be multiples.

      1. **Time interval covered:** i.e., Dates of data sampling, i.e., 1954 - 1989.

      2. **Update Schedule:** Updated schedule, if known.

2. Derivation methods for data

The purpose of this step is to describe how the data was brought into the system. By knowing how the data was created and the technology used, limits in the accuracy may be deduced

a. Methods of derivation

1. Preautomation Compilation: Compilation information, i.e. Photointerpreted from 1:24000 scale maps

2. Digitizing_Scanning_Transformations: .

3. Equipment

a. Model: Model information, i.e., ANA Tech Eagle 4080 large format scanner.

b. Resolution: i.e., 400 dpi Altek Table, accuracy of .001 inches.

c. Tolerance of Digitizer: i.e., Tolerance of Altek tables is .003 inches.

b. Date of Automation

1. Initial Date: i.e., Between 9/80 and 11/90

2. Update Schedule: i.e., Every five years.

c. Control Points: Known information on control points used. A control point is any station in a horizontal or vertical control network that is identified in a data set or photograph and used for correlating data show in that data set or photograph. A coordinate system is a particular kind of reference frame system, such as plane rectangular coordinates or spherical coordinates, that uses linear or angular quantities to designate the position of points within that particular reference frame or system.

d. Explanation of procedures used to digitize/scan/transform the data

This is a description of procedures that would indicate the quality/accuracy of the data captured. Information that would not provide insights should not be included. Transformation routines that are supplied by vendors should include the name of the transformation module. User-created transformations should include the following:

1. Name of transformation methodology: Any appropriate methodology.

2. Description of Algorithm: Description of any algorithm used.

3. Mathematics used in the transformation: Relevant mathematics.

4. Set of Sample Computations: If there are any computations, enter a sample here.

e. Software system and version used: i.e., DOS 5.1, OS/2, etc.

B. Positional Accuracy

Tests of accuracy after all transformations have been performed on a particular layer.

1. Linework Completeness Check

a. Date: Date of test.

b. Value: Identify value.

c. Method Used to Derive Value: Methodology.

2. Linework Positional Accuracy Check

a. Date: Date of test.

b. Value: Identify value.

c. Method Used to Derive Value: Explanation of how the above value was derived.

3. Absolute Measure of error reference

Provides a numerical estimate of expected discrepancies.

a. Value: Value of error reference.

b. Method Used to Derive Value: Select one or more of the following options.

1. Deductive estimate — The deriving of a conclusion by reasoning. It may be necessary that a best guess is given. Any assumptions that were made to derive the conclusion should be described.

a. Date of tests: Date of tests.

b. Results: Results of above test.

2. Internal Evidence (geodesy)

a. Date of tests: Date of tests

b. Results: Enter results of above test.

3. Comparison to Source

4. Independent source of higher accuracy

a. Date of tests: Date of tests.

b. Results: Results of above test.

C. Attribute Accuracy

Accuracy assessment for measures on a continuous scale shall be performed using procedures similar to those used for positional accuracy (providing a numerical estimate of expected discrepancies).

There has been considerable discussion on how much detail is required at this step. It is the view of the developers of the report that as much information be provided as possible. This does not mean that a test must be performed that wouldn't normally be performed, but it does mean that all performed tests should be reported. The level of reporting should be at such a level as to be useful to the recipient.

1. Linework Completeness Check

a. Date: Date of check.

b. Value:

c. Method Used to Derive Value: Method used to derive above value.

2. Linework Attribute Accuracy Check

a. Date: Date of check.
b. Value:
c. Method Used to Derive Value: Method used to derive above value.

3. Absolute Measure of error reference

a. Value: Value of error reference

b. Method Used to Derive Value: Method used to derive value of error reference

1. Deductive estimate The deriving of a conclusion by reasoning, with supporting information.

a. Date of tests: Date(s).

b. Results: Results of above test.

2. Internal Evidence (geodesy)

a. Date of Tests: Date(s).

b. Results: Results of above test.

3. Comparison to Source

4. Independent source of higher accuracy

a. Date of tests: Date.

b. Results: Results of above test.

D. Logical Consistency

1. Cartographic Tests

a. Test Performed: Cartographic tests performed.

b. Date: Date cartographic test was performed.

c. Result: Results of cartographic test here.

d. Do lines intersect only where intended? Answer with Yes, No or Unknown.

e. Were duplicate lines eliminated? Answer with Yes, No or Unknown.

f. Are all polygons closed? Answer with Yes, No or Unknown.

g. Have dangles been eliminated? Answer with Yes, No or Unknown.

h. Have slivers been eliminated? Answer with Yes, No or Unknown.

i. Do features have unique identifiers? Answer with Yes, No or Unknown.

2. Topological Tests

Topology is a branch of geometrical mathematics concerned with order, contiguity and relative position, rather than actual linear dimensions. Topological error checking is the process of ensuring the logical consistency of data is intact: all polygons are closed, all arcs are connected to nodes, etc.

a. Test Performed: Topological test performed.

b. Date: Date of test.

c. Software Used: Name and version of software used in topological test.

d. Results: Results of test.

1. Test for polygon coverage

a. How many polygons are represented on the digital map product? Number

b. Has a polygon closure been verified? Yes or No.

c. Are polygon-IDs assigned to each polygon on the digital map? Yes or No

1. Do polygons have more than one polygon-Id? Yes or No

2. Are the Polygon-Ids unique? Yes or No.

2. Test for line coverage

a. How many lines are represented on the digital map product? Number.

b. Do the line segments have unique line segment values? Yes or No.

c. Is the digital map topologically clean? Yes or No.

3. Test for point coverage

a. How many points are represented on the digital map product? Number.

b. Are the Point-Ids unique? Yes or No.

E. Completeness of Source Materials

The purpose of Completeness of Source Materials is to describe the set of information collected in comparison to a larger set. For example, a set called "Well Data Points" may be all manmade wells in the area described or it may be only private wells used for homes.

1. **Selection Criteria:** Identify how the objects were identified.

2. **Definitions Used:** Definitions used for selection criteria.

3. **Other relevant mapping rules:** i.e., minimum mapping units, etc.

4. **Deviation from standard definitions and interpretations:**

5. **Description of relationship between the objects**

6. **Tests for taxonomic completeness**

a. **Procedures:** Procedures of the test used here.

b. **Results:** Test results.

APPENDIX C

GIS AND FISHERIES MANAGEMENT

Kenneth D. Haddad
Gail McGarry MacAulay[1]
William H. Teehan[2]

INTRODUCTION

Florida's marine resources are being stressed by a multitude of problems related to growth of the human population; these problems include loss of wetlands, drainage alterations, urbanization, boating impacts, and fishing pressures. As pressures on marine resources continue to increase, it has become evident that data needed to make informed management decisions are either lacking or are inaccessible. Gathering this needed information through monitoring and research is an important step towards better informed management; however, simply gathering this information will not solve the problems associated with managing that information and making it readily available. Unless advanced information-management technologies are instituted in resource management agencies, effective utilization of the information to better manage our resources will not occur. Geographic Information System (GIS) technologies may provide the tool needed to translate and synthesize geographically oriented marine resources information in Florida.

A GIS is a data-management and information-analysis system that is able to capture, synthesize, generate, retrieve, analyze, and output spatial information. GIS technology is revolutionizing geographical analysis and has applications in many scientific fields (Cowen, 1988; Parker, 1988; Peuquet and Marble, 1990). Haddad and Michener (1991) foresee Geographic Information Systems evolving into the primary tools for addressing coastal resource-management issues, and published articles and workshops related to GIS technology are now evident in almost every field of science and management. A field in which GIS has not had adequate exposure or use is fisheries management.

Issues facing Florida's fisheries include stressed fish stocks, user conflicts, and impacts to fish habitat. The Florida Marine Fisheries Commission (MFC) and the Florida Department of Natural Resources (FDNR) are working together to advance GIS applications so that they can be used in managing Florida's fisheries.

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FISHERIES MANAGEMENT

Florida Marine Fisheries Commission

The MFC was created in 1983 by the state legislature and consists of seven commissioners, who are appointed by the Governor and confirmed by the Senate, and a support staff. The MFC is charged with the management and preservation of Florida's renewable marine fisheries resources. Chapter 370.027, Florida Statutes, grants the MFC exclusive rule-making authority in the following areas relating to marine life (with the exception of endangered species): gear specifications, prohibited gear, bag limits, size limits, species that may not be sold, protected species, closed areas (except for public health purposes), quality control of seafood (except for oysters, clams, mussels, and crabs), fishing seasons, and special considerations relating to egg-bearing females. Rules that are adopted by the MFC are subject to approval by the Governor and Cabinet.

Marine Resources Geographic Information System

The FDNR is mandated through Chapter 370, Florida Statutes, to manage, protect, and enhance Florida's marine resources in the best interests of the resources and the public. The FDNR Division of Marine Resources' Florida Marine Research Institute (FMRI) has implemented the Marine Resources Geographic Information System (MRGIS) as a tool to more effectively understand and manage coastal and marine resources. The MRGIS consists of an array of computers, software, and regional and statewide databases. The primary MRGIS software includes ARC/INFO and ERDAS. Computer hardware and software are the essential technological components of a GIS, but the power of a GIS lies in its stored databases. One of the greatest obstacles to effectively managing Florida's fisheries is the lack of a consolidated information base that can be manipulated and synthesized to provide timely assistance and guidance on research and management issues. We believe that the MRGIS can be used to overcome this obstacle. The MRGIS is being developed as the primary tool to be used in translating and synthesizing geographically oriented marine resource information in Florida. The MRGIS can take information from a variety of independent research programs, data-collection efforts, and management policies of federal, state, and local agencies and integrate it for correlated multi-disciplinary analysis and presentation, thus initiating the rudiments of an ecosystem approach to resource management. This approach to effectively utilizing information and managing data will serve the long-term goals of fisheries managers.

SHRIMP MANAGEMENT: A CASE STUDY

The integration of GIS capabilities and information into the decision-making process of fisheries managers has been an arduous process because of the difficulty in assembling the necessary basic information, on a statewide basis, to address the many complex issues associated with Florida's marine fisheries. However, advances are being made, and the use of the information integrated by the MRGIS in developing a plan for the long-term management of shrimp lays the foundation for using GIS technologies in fisheries management.

Shrimp Management

Shrimp is the most important invertebrate marine animal harvested in the state, with an estimated 1990 ex-vessel value of $41,531,527. Florida has three main targeted species of penaeid shrimp: pink shrimp, *Penaeus duorarum*; white shrimp, *P. setiferus*; and brown shrimp, *P. aztecus*. Another penaeid, the seabob, *Xiphopenaeus kroyeri*, is seasonally targeted in certain northwest Florida areas. Rock shrimp, *Sicyonia brevirostris*, and the royal red shrimp, *Pleoticus robustus*, are also landed in Florida; however, the harvesting of these species occurs exclusively in federal waters.

The MFC has been developing a statewide shrimp management plan since 1987 with the following goals: maintaining healthy stocks, ensuring fair and optimal distribution among user groups, protecting habitat, minimizing bycatch, standardizing regulations, minimizing conflict with other fisheries, and ensuring a high-quality product. The shrimp fishery was divided into three user groups: recreational, live-bait, and food production. To account for habitat and gear differences, five contiguous management regions in Florida were designated: the northeast, Big Bend, southwest, southeast, and northeast regions.

The schedule for completing the shrimp management plan calls for two phases of rule-making. The first phase has been completed, and the rules became effective January 1992. Rules developed for Florida's extensive inshore shrimp fishery during this phase of the plan addressed allowable gear specifications, mesh size of nets, and shrimp count for harvesting activity inside the International Regulations for Preventing Collisions at Sea (COLREGS). In the first phase of the plan, numerous local laws were repealed, which simplified inshore and nearshore shrimp regulations and standardized the fishery on regional and statewide levels. The Big Bend region of Florida is the only area where these new regulations include harvest in all state waters. The second phase of rule-making will address the finfish bycatch associated with shrimp trawling and also the adoption of a zone management plan to determine allowable shrimp-harvesting areas.

MRGIS Database Development

Because of the complex process involved in developing the shrimp management plan and the goals of the MFC to address user conflict, maintain a high-quality shrimp population for harvest, and protect habitat, the information requirements are substantial. Basic information identified as important to the planning process includes nautical chart coastline, depth contours, aids to navigation, benthic communities, managed areas, shrimping areas, and, in some cases, potential shrimp nursery areas. All of these databases are geographically layered in the MRGIS so that any combination of information can be analyzed and produced on maps (Figure 1).

Each of the data layers obtained during development of the shrimp management plan had unique purposes as well as unique problems. Much of the data were from external sources and required varying levels of verification and quality control. Problems in the digital data ranged from errors in digitizing to errors introduced in converting the data to make it compatible with the MRGIS. When data were not available, MRGIS and MFC staffs collected the needed information or the data gathering was contracted. Cooperation in data collection has been essential in our effort to develop an extensive MRGIS database.

Nautical Chart Coastline

The nautical-chart coastline database is a generalization of the Florida coastline digitized primarily from National Oceanic and Atmospheric Administration (NOAA) nautical charts. A coastline from nautical charts was selected after numerous options were presented to the MFC and the public at a MFC meeting. It was determined that

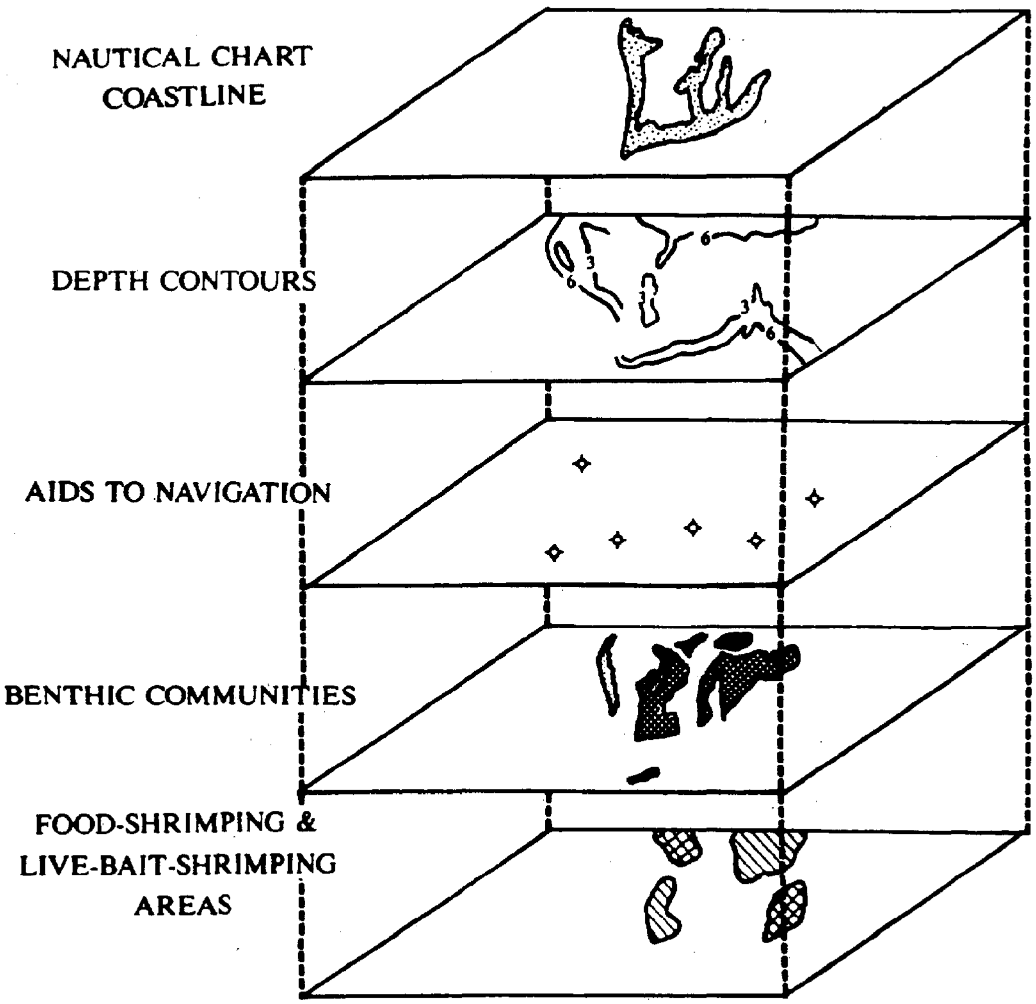

Figure 1. Conceptual view of the relationship among several GIS data layers used to assist in shrimp management planning.

because both the public and the MFC used NOAA nautical charts as common reference maps, the presentation of MRGIS information would be best understood in that format. The majority of the digitized charts were at a map scale of 1:40,000, but some charts ranged in scale depending on their availability. The U.S. Fish and Wildlife Service developed this database for the FDNR from digital line data provided by NOAA.

Benthic Communities

Benthic communities, including seagrass, mangrove, saltmarsh, non-vegetated bottom, oyster reef, and coral communities, play a significant role in supporting Florida recreational and commercial fisheries.

The areal distribution of these communities is important to many issues facing the MFC and the FDNR. Shrimp and other commercial and recreational species utilize seagrass, saltmarsh, and mangrove areas as habitat and nursery areas. The seagrass communities are primary fishing grounds in the bait-shrimping industry. Shrimp managers require information on habitat impacts, bycatch, gear use, and zoning relative to benthic communities.

The benthic-community data used in developing a state-wide database were compiled from a myriad of sources. Where possible, existing data, which were developed and verified by other agencies, were utilized. For areas about which existing, reliable data were not available, standard remote-sensing techniques utilizing satellite imagery and aerial photography were employed.

Depth Contours

Depth contours are common features on NOAA nautical charts and represent common features of orientation considered important to map presentation. In addition, using depth ranges to isolate areas of interest (e.g., the location of seagrass in depths of less than 3 ft) allows managers to analyze the relationships between shrimping activities and the resources.

Depth-contour data were automated for the following depths: 3 ft, 6 ft, 12 ft, 18 ft, 30 ft, and 60 ft. In addition, channels and spoil areas were identified. Data were digitized from NOAA nautical charts (primarily 1:40,000 scale) by an independent contractor and are compatible with the coastline data layer. All depth-contour data were required to carry attributes as both lines and polygons for maximum usage in the GIS. This requirement allows the flexibility of highlighting individual contour lines as well as providing polygons to query other layers on the basis of depth range. For example, although the data are generally depicted as lines in maps, we have found it useful to extract seagrass areas that occur within specific water depths. Problems encountered during the development of this database included incomplete contour lines, differences in lines on overlapping charts, and a single line representing several depths. Data were interpolated to complete contour lines and a labelling methodology was developed to allow selection of contours for a specific depth when a single contour segment represented several depths.

Shrimping Areas

The bait-shrimp-fishing industry maintains live shrimp in holding tanks for distribution as live bait, whereas food shrimp are usually frozen onboard the shrimping vessels prior to processing. The locations of live-bait-shrimping and food-shrimping areas are critical to the development of the shrimp management plan. The MFC is using this information to assess the location of potential habitat impacts, develop an understanding of potential user conflicts, maximize habitat protection, and minimize impact to the fishing industry.

Locations of live-bait-shrimping and food-shrimping areas were determined by a team of FDNR and MFC staff, who met with shrimpers and their representatives. Shrimpers identified those areas where they fished by drawing polygons on NOAA nautical charts. When appropriate, references were made to the seasonality of these shrimping areas. The marked-up nautical charts were returned to the FMRI for digitizing into the MRGIS as a separate data layer. The accuracy of this particular data layer was dependent on the cooperation of the shrimpers.

Aids to Navigation

Landmarks that can be used in determining position are called aids to navigation. Channel markers, lighthouses, buoys, water tanks, piers, marinas, and shipwrecks are examples of navigational aids that appear on NOAA nautical charts. Channel markers and buoys were determined to be the most important features for inclusion in the aids-to-navigation data layer. Both provide a visual reference for location, and the MFC and other marine resource managers use them as zone-boundary references for regulatory and management purposes.

Aids-to-navigation data to be entered into the MRGIS database were purchased from the NOAA National Ocean Survey (NOS). Data for the entire country were provided to the FMRI as an ASCII text file. The data were searched for features that fell within the minimum and maximum latitude and longitude values for Florida. The data presented numerous problems that proved difficult to correct. Labeling inconsistencies (e.g., buoys were abbreviated several different ways) made sorting of the data difficult. In addition, multiple entries for a given location and the inclusion of outdated information (e.g., positions of channel markers were given even if they were no longer at that location) were recorded. In some cases, extraneous items from the charts, such as compass roses, were included in the digital database. Inconsequential data were eliminated from the database and errors were corrected.

Managed Areas

Managed areas have also been included in the database for some regions of the state, which provides an understanding of jurisdictional boundaries and existing management zones relative to resources and issues of regulatory responsibilities. Existing state and federal jurisdictional boundaries and existing shrimp management zones have been utilized. Boundaries for managed areas were either interpreted from legal descriptions or were digitized from NOAA nautical charts. It is expected that the locations of additional managed areas (e.g., National Marine Sanctuaries and Florida Aquatic Preserves) will be required for future planning.

APPLICATIONS OF THE SHRIMP MANAGEMENT PLAN

The identification, collection, control of quality, and integration of geographic data into the MRGIS have been difficult and time-consuming. Information provided to the MFC to be used in planning for shrimp management has been in the form of maps that depict various combinations of data layers and in the form of results of simple analyses designed to geographically relate different data layers.

Map Making

Until the users fully understand the analytical power of the MRGIS, they will continue to request primarily information in the form of maps that portray all or different combinations of the data layers. Several layers of information for a portion of the Tampa Bay region of Florida are depicted in Figure 2. These maps are produced in color on an electrostatic plotter in large-scale format to enhance the visual presentation of the information.

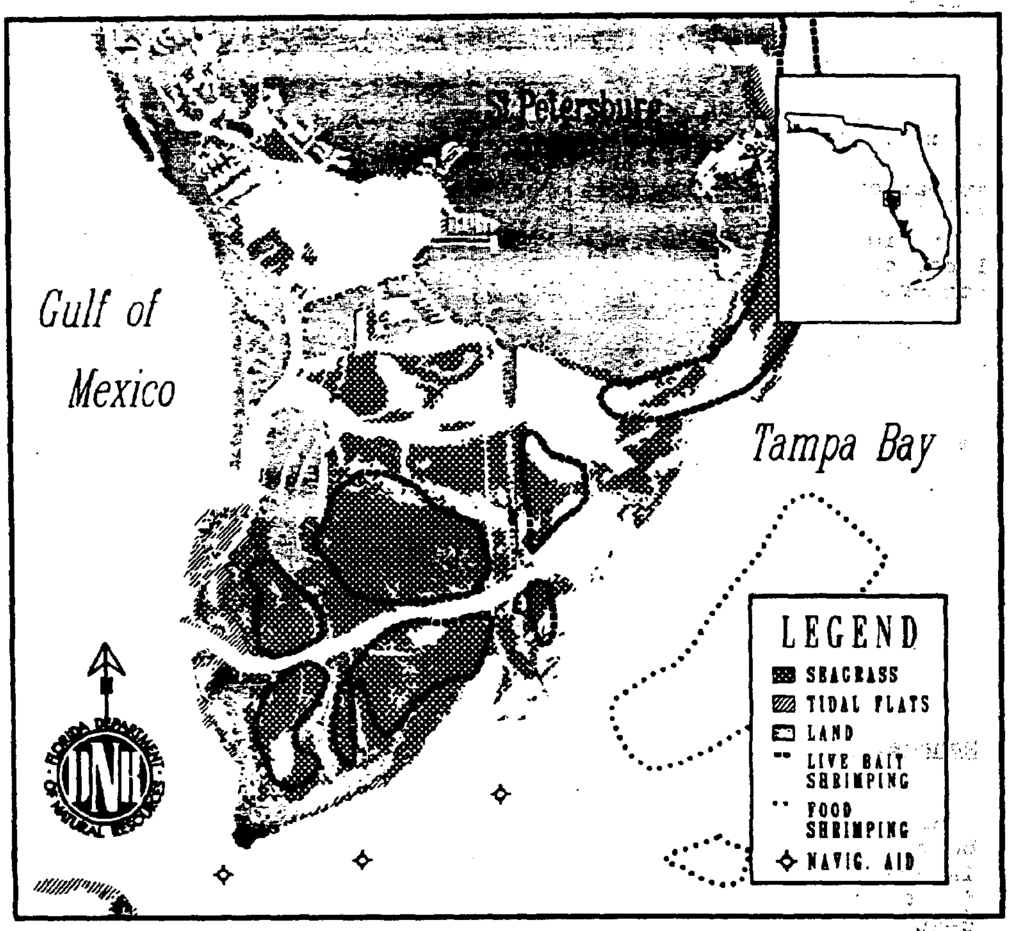

Figure 2. A MRGIS map of a portion of the Tampa Bay region showing the overlay of coastline, benthic communities (seagrass and unvegetated tidal flats only), live-bait-shrimping, food-shrimping areas, and aids to navigation.

The MFC staff uses these maps in formulating the management plans for a given region. Issues relative to habitat protection, user conflict, seafood quality, and the like, vary among regions, and the maps provide a geographic presentation of these differences. Maps are of particular importance in the development of potential zones for managing user conflicts and maintaining harvestable yields of shrimp. The MFC staff developing the management plan also uses maps to support their recommendations and present them to the commissioners of the MFC.

In addition, maps are used at public hearings and workshops to present components of the management plan to the public. It is expected that in the long-term, maps will be one of the more tangible types of information used in public presentations and will provide the focus for public understanding and feedback on many of the issues.

The combining of different layers of information for presentation is rudimentary from the perspective of advanced GIS applications. However, when the result is the visualization of information in a form and content that previously was not available, the advantage is significant.

Information Analysis

The FMRI and MFC are determining acreage (e.g., acres of seagrass and shrimping areas) and investigating the relationships among some of the layers of information. Results of an analysis of the Tampa Bay region to determine the depth and acreage of seagrasses that occur within live-bait-shrimping or food-shrimping areas are shown in Table 1. Habitat-impact and bycatch issues are better addressed with this type of information because the impacts of management options can be assessed. For example, if resource managers were designing shrimp zoning in Tampa Bay to minimize impacts to seagrass, they could see from the information in Table 1 that the live-bait-shrimping areas are the only areas that include seagrass. In fact, 8,464 acres (44%) of the total live-bait-shrimping area is seagrass. However, 7,582 acres (90%) of the total seagrass found in the live-bait-shrimping areas are in depths of less than 3 ft, and only 10,413 acres (54%) of the total area shrimped is in less than 3 ft. This implies that zoning options minimizing shrimping in depths less than 3 ft would protect 90% of the seagrass areas shrimped but would reduce the primary shrimping areas by 54%.

Table 1. Result of a MRGIS analysis to determine the amounts of seagrass found in different depth ranges within live-bait-shrimping and food-shrimping areas in the Tampa Bay region.

LIVE-BAIT SHRIMPING			
DEPTH	SEAGRASS ACRES SHRIMPED	NON-SEAGRASS ACRES SHRIMPED	TOTAL AREA SHRIMPED
< 3 Feet	7,582	2,831	10,413
3 to 6 Feet	347	4,556	4,903
> 6 Feet	535	3,313	3,848
TOTAL	8,464	10,700	19,164

FOOD SHRIMPING		
DEPTH	SEAGRASS ACRES SHRIMPED	NON-SEAGRASS ACRES SHRIMPED
< 3 Feet	0	40
3 to 6 Feet	0	575
> 6 Feet	0	32,209
TOTAL	0	32,824

A visual presentation of the results of the geographic analysis depicting the areas of seagrass in depths less than 3 ft that are shrimped in a portion of the Tampa Bay region is shown in Figure 3. Any combination of map layers and results from Table 1 can be geographically depicted to enhance the understanding of the information. Of course, results of shrimping-bycatch and seagrass-impact studies, economic values, resource allocations, and many other factors contribute to the final determination of shrimping zones. The real achievement of the MRGIS analyses is that this level of information and the ability to look at hypothetical management options have never been available in this way before.

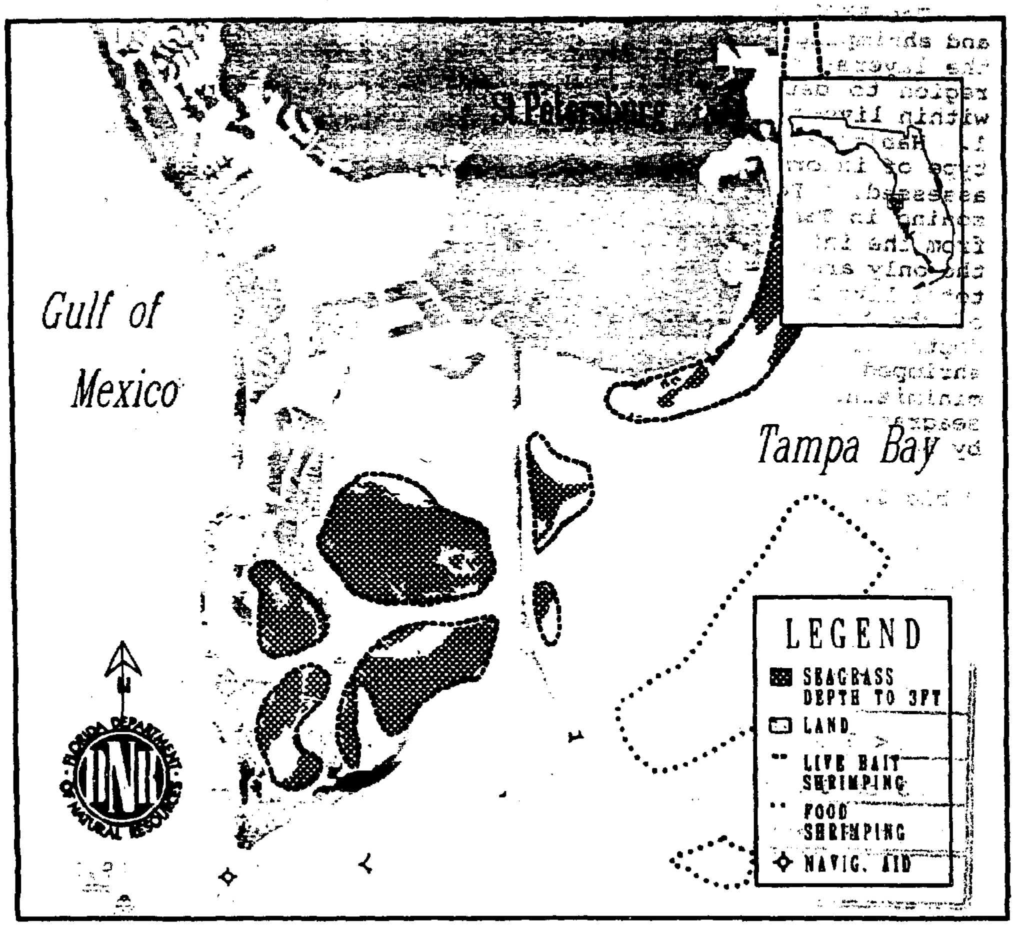

Figure 3. A MRGIS map of a portion of the Tampa Bay region showing the location of seagrass areas in less than 3-ft depths found in the live-bait-shrimping or food-shrimping areas.

Conclusions

There are many issues facing fisheries managers in Florida. We have demonstrated that GIS technology can be a valuable tool in developing fisheries management plans. Because much of the information used by fisheries managers is of a geographic nature, it is expected that the application of GIS technologies will continue to expand. However, fisheries managers must realize that the power of the GIS is in the data. Analyses are easy. Most failures in using GIS technology result when managers and GIS experts fail to properly identify the need for, plan for, and commit to data collection, acquisition, and quality control. If these data issues are not addressed, GIS technologies will not prove successful in the long-term.

The process of adapting GIS techniques to the needs of the MFC staff developing the shrimp management plan has not always been easy. The expectations of the MFC regarding the availability of data layers necessary for the shrimp management plan and the FMRI's ability to properly develop them were occasionally different. Schedules for public hearings and workshops had to be adjusted to accommodate for the time required to enter accurate databases into the MRGIS. The outcome of this interactive process between MFC and FMRI staffs, however, has been a successful application of GIS for fisheries management.

If properly implemented, GIS technology can become more valuable every year in managing Florida's fisheries. By including water-quality, physical, meteorological, socio-economic, and species information, management options can be explored with a better understanding of the potential results of a management decision. The next technological advancement will be to transfer the ability to manipulate the information to the MFC staff. The FDNR and MFC staffs are beginning work to provide the MFC with the capability to display different combinations of map layers and the results of analyses. The goal is to make these capabilities available not only for technical analyses but also for low-cost, interactive displays at public workshops, hearings, and meetings. Only then will the maximum value of the technology be fully realized.

Appendix

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